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Full Name of Author — Nom complet de l'auteur
MERRILL LAYNE MARSHAL

Date of Birth — Date de naissance
13 DEC 46

Country of Birth — Lieu de naissance
USA

Permanent Address — Résidence fixe
11720 48 AVE
EDMONTON ALBERTA

Title of Thesis — Titre de la thèse
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Name of Supervisor — Nom du directeur de thèse
Dr. D.S. Grant

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SIGNAL DIRECTED BEHAVIOR IN DOGS

BY

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A THESIS
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PERMANENT ADDRESS:

11720 48 Avenue
Edmonton, Alberta
Canada T6H 0E6

DATED 27 September 1982

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Signal directed behavior in dogs submitted by M. L. Marshal in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

Supervisor

External Examiner

Date 27 September 1982

Dedication

To Paulette

Abstract

The possible operation of a stimulus-task interaction was explored in a study of signal-directed behavior in dogs. Eight dogs were trained in a preparation designed to confirm and extend the findings of Jenkins et al. (1978) that dogs displayed signal directed behavior (SDB) to visual cues predicting food delivery. Two experiments tested a two-by-two cross of signal (one or two stimulus conditions) with task (go/no-go or right-left discrimination). Observations of orientation, approach, contact, and various specific social responses were recorded as evidence of signal directed behavior.

In Experiment 1, two phases of go/no-go training were given to four dogs. In one phase, one cue was presented from two locations to signal delivery or non-delivery of food on a given trial. In the other phase, two cues were presented from one location to signal whether food was to be made available. The results showed signal directed behavior to be a robust phenomenon, but no interaction of task and cue condition was observed. In Experiment 2, two phases of training were given in a food availability problem in which food was delivered on every trial, but the location for the delivery varied between two locations. In this experiment, one cue from two locations or two cues from one location signalled the food delivery site. Results in this experiment were similar to those in Experiment 1, in that some of the dogs consistently displayed signal directed behavior but in

both test conditions.

The general result was that virtually all of the individual responses recorded by Jenkins et al. were observed here, but the anticipated interaction of task and cue condition did not develop.

Several possible explanations for the failure to identify an interaction were explored. One possibility was that the sensitivity of the measure of an interaction was not sufficient to discriminate an interaction, and so no interaction was observed. A second possibility focused on the fact that training conditions may have supressed or overshadowed an interaction. Finally, it was suggested that the the behavior in question would be more adaptive if no interaction were to occur.

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The list of people whom I would like to acknowledge is long. To list them all would take a volume. Each one contributed something of value to my academic career that will never be forgotten. I shall, if the opportunity arise, thank each one personally.

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Also worthy of acknowledgement is my very dear friend, Carl Gustavson. Our meeting just over 15 years ago started me on a course the end of which I am just now approaching. More than anyone else, he is responsible for my being here.

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Here and there along the way are the people whose parts may be smaller, but no less important. The group includes, but is certainly not limited to, FRANK hovell, friend and mentor; Bob Brewster and Bill Koch, "good friends and good beer," as the jingle goes; Joe, Linda, and Steve; and Jim and Helen. If I've left your name out, chalk it up to the fog in my brain, and accept my apology.

Last on this list, but there from the start, are my parents. From my very first day in school they have been behind me encouraging, praising, prodding, reproaching. It is they who taught me that I was capable of getting here, and they who taught me to do it the best I could. It was they who taught me to be happy with only the best I could do (but only dissatisfied,, not destroyed, with less). When all is said and done, it is they, whether they like it or not, who are responsible. So after years and years trying I can finally say, "We've done it!"

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I. Introduction

In 1968, Brown and Jenkins demonstrated that pigeons could be conditioned to peck keys simply by arranging a contingency between presentation of the discriminative stimulus (Sd) and delivery of the reinforcer (Sr+). By illuminating the key light for several seconds immediately prior to delivering the reinforcer, Brown and Jenkins were able to produce consistent key pecking despite the fact that they neither shaped the response nor made Sr+ delivery conditional on response occurrence. This phenomenon was called autoshaping, reflecting the fact that the response came to be displayed via exposure to an Sd-Sr+ contingency. It might be mentioned that in many ways this preparation follows the traditional Pavlovian procedure: the sole contingency is between CS presentation and US delivery. However, an important deviation from traditional applications of the Pavlovian procedure, critical to the demonstration of the behavior, is that in these studies subjects are not restrained.

Conceptions of the phenomenon underwent several changes as more was discovered about the nature of the behavior and its controlling factors. In a recent monograph, Hearst and Jenkins (1974) suggested that autoshaping was an instance of a more general phenomenon which they called sign tracking. The authors proposed the name sign tracking to refer to behavior directed both toward and away from a stimulus as a function of either a positive or negative correlation between presentation of the stimulus and delivery of a reinforcer. The stimulus was considered to be a sign because it predicted the presence or absence of the reinforcer. Tracking was to be interpreted liberally in that it referred both to an organism's orientation, approach, or contact responses directed toward a sign; and to withdrawal or responses directed away from a sign.[1]

A demonstration by Jenkins, Barrera, Ireland and Woodside (1978) that dogs direct behavior toward a stimulus predicting food delivery added another example to the literature, and another entry to the list of names: signal-centered behavior (hereafter called signal directed behavior, or SDB). In that study, the traditional autoshaping contingency was applied to unrestrained dogs in an open experimental chamber. In an effort to clarify the nature of signal centered reactions and their controlling stimuli, a single auditory-visual compound was presented from the right or the left of an unrestrained dog on a mat at one end of an enclosure. Presenting the stimulus from one side (S+) signaled food delivery at the end opposite the mat, while presenting it from the other side (S-) signaled no food. As was the case in earlier studies, no explicit response to the stimulus was demanded for the reinforcer to be delivered.

---

[1] An interesting corollary to sign tracking was proposed by Boakes (1977). He coined the term goal tracking to describe the fact that, rather than approaching or tracking the signal, animals occasionally will approach or track the goal or food location. This phenomenon seems to occur more frequently as a function of such factors as increasing explicitness of the goal in conjunction with decreasing explicitness of the signal. However, the nature of goal tracking lies outside the primary scope of this discussion, and will be pursued no further.

The authors examined the behavior exhibited by the dogs during stimulus presentation; given differential responding to the S+ and S-, their interest can be translated into two fundamental questions. First, do the dogs discriminatively approach the food delivery site or do they respond more to the signals themselves? Second, assuming the latter outcome, what type of behavior might be directed toward them? Would the S+ acquire the hedonic properties of the signaled event and thereby evoke consummatory action patterns? If so, we might expect to see the dogs approach and lick, bite and/or chew on the source of the stimulus. In other words, they should treat it as if it were food. Or, would the S+ function in some other, related manner, e.g., become the focus of other hedonically motivated (non-consummatory) behavior? In this instance, we might see goal tracking or the behaviors that Jenkins et al. observed: signal approach and contact, barking, tail-wagging, begging and other similar canid behaviors. Finally, might the S+ and subsequent food reinforcement come to control unrelated, non-feeding behavior via instrumental conditioning? The possibilities for responding here are innumerable.

The Jenkins et al. results were unambiguous. For four of the five subjects, S+ and S- controlled consistent SDB reflecting their predictive significance. The S+ was the target of behaviors which were distinctly different from both early training responses to the S+ and goal directed responding. Specifically, presentation of the S+ was followed by approach to and occasional contact with the stimulus source. In addition, individual response patterns manifested a variety of social play behaviors and what were judged to be food soliciting responses, such as begging, barking, and prancing. On the other hand, the S- was associated with such responses as a general increase in activity or with no responding at all.

Two important questions about this research may be raised. Jenkins et al. posed one question: How can this result best be explained? The other question, arising from the research of Konorski and two of his associates, is: Can it be shown that the display of SDB is subject to interactions among the elements of the SDB preparation? Answers to these questions must be sought both in traditional explanations of learning and other perspectives which diverge from the traditional views in a variety of ways.

Whether there may be an interaction will be discussed in a subsequent section. This point concerns the nature of the relationships between the elements of the conditioning paradigm, and whether signal directed behavior will vary as function of interactions among them. This possibility is suggested by a series of studies carried out in Konorski's laboratory, in which relative performance of the target response proved to be a function of qualities of the cue and the response. That a similar interaction might also be demonstrated in an extention of the study by Jenkins et al. is the primary focus of this research.

Whether an adequate explanation for SDB has yet been proposed can also be questioned. Of particular interest to the question of explaining SDB is whether concepts taken from contemporary learning theory will suffice to clarify the phenomenon, or whether models of behavior which rely on new concepts – or on fundamentally re-worked old concepts – must be developed. Jenkins et al. have suggested that models proposed prior to 1978 were inadequate, citing a variety of shortcomings in each of them. Their explanation, and the original hypothesis of which it is a variant, will be discussed next.

A. The Origins of Signal Directed Behavior

It might be argued that the only major difference between the SDB preparation and the Pavlovian preparation is the lack of restraint, and that Pavlovian concepts should provide sufficient explanation of the phenomenon. Similarly, it might be suggested that because of the lack of restraint instrumental contingencies come into play, and can provide the necessary explanation for the nature and variation in SDB that Jenkins et al. found. These possibilities will be examined first for their relative strengths and weaknesses. Then, an alternative view will be presented which emphasizes the form and evolutionary origins of SDB.

Traditional accounts of learning in the Pavlovian preparation

In the prototypical Pavlovian procedure, a subject is presented with a neutral, or conditioned stimulus (CS) followed by a biologically important, or unconditioned stimulus (US). After several presentations of the two stimuli, responding which previously occurred to the US but not the CS now occurs upon presentation of the CS alone. The previously neutral stimulus apparently is no longer neutral. Why the stimulus has changed is still a matter for discussion. Mackintosh (1974) described three attempts to explain this phenomenon. The first, stimulus substitution, was suggested by Pavlov. The other two applied the law of effect to the Pavlovian procedure, implicating instrumental reinforcement in the preparation. Each will be described briefly.

Pavlov (1927/1960) proposed that the CS became associated with and substituted for the US, thereby becoming an elicitor itself. There are two general implications of this arguement. The first is that if the CS substitutes for the US, then the conditioned response (CR) to the CS should resemble the unconditioned response (UR) to the US. Second, a strict substitution view would demand that the relationship between the CS and the CR resemble the relationship between the US and the UR. For example, the latency, duration and amplitude of the CR should compare favorably to those of the UR.

Regarding a stimulus substitution approach to the Pavlovian preparation, Mackintosh evaluated a number of studies concerning CR-UR similarity, and concluded:

> In spite of almost universal rejection, stimulus-substitution theory is strikingly resilient: the variety of responses elicited by a CS closely matches the variety of responses elicited by the UCS. Apparent exceptions become less convincing on closer inspection and attempts to read into an animal's behaviour signs of expectation and preparation tell us more about the experimenter's preconceptions than the subject's behaviour.
> (p. 107-108, 1974)

Jenkins et al. found that such similarity did not hold for SDB, however, since their dogs did not "consume" the stimuli, but rather treated them in dramatically non-consummatory ways. Thus, though Mackintosh concluded that a stimulus substitution view of Pavlovian conditioning cannot be rejected, that view must be held in abeyance since it seems not to apply to SDB.

Neither do applications of the law of effect resolve questions about how best to describe Pavlovian conditioning. Those explanations were held by Mackintosh to be variants of a view which he suggested can be traced to the writings of Hull. In one case, superstitious instrumental reinforcement is said to occur because the CR is followed by a responsestrengthening event (ingestion of food or termination of shock). That is, while the procedure appears to be Pavlovian, in fact it is instrumental. The other approach suggests that both preparations can be found in one design. While delivery of the US is programmed to be independent of the subject's behavior, the value of that stimulus may be affected directly by the occurrence of the CR. By preparing the subject for the US, the CR mitigates an aversive US or enhances an appetitive US. This change in the value of the US, compared to its value in the absence of the CR, renders plausible the argument that the CR is in fact an instrumental response.

It has been proposed that instrumental reinforcement is an important factor in the Pavlovian preparation, ranging in influence from a major determinant of the form of the CR to only one of many factors which may influence the CR. Taking the strong position, Skinner (1948) suggested that instrumental reinforcement not only occurred in Pavlovian conditioning but that it might be the central mechanism by which CRs arose. He proposed that noncontingent delivery of reinforcers would strengthen whatever behavior is occurring at the moment of reinforcement. Such noncontingent reinforcement would have the effect that, over the course of many trials, one behavior would become increasingly more likely to be expressed, and therefore to be reinforced. As a result of this increasing likelihood of occurrence, apparently non-instrumental preparations could produce responses instrumentally. The crux of Skinner's arguement rested on the assumption that behavior in the superstitious conditioning preparation was far more varied than might be predicted by a strict Pavlovian view of the procedure. He concluded, therefore, that the superstitious behavior had been instrumentally conditioned.

Skinner's interpretation of the superstition experiment remained the dominant one until the early 1970's, when Staddon and Simmelhag (1971) reevaluated the superstitious conditioning paradigm. They paid close attention to interim behaviors (those occuring at times other than immediately prior to reinforcement) and terminal behaviors (those which became increasingly more frequent as Sr+ delivery approached). They found that pigeons consistently oriented, moved toward the key and pecked (but not necessarily the key) as the end of the reinforcement interval approached. These results suggested to Staddon and Simmelhag that interim behavior is far from idiosyncratic but instead reflects a biological organizing factor inherent in the nature of the pigeon. This finding was to have a profound effect on contemporary experimental psychology. In fact, Schwartz (1978) wrote that this research by Staddon and Simmelhag "...may turn out to be one of the most important contributions to the analysis of behavior in many years" (p. 132). The significant impact of the paper came from its explicit application of evolutionary theory to the understanding of the reinforcement mechanism. Using the

Darwinian concepts of variation and selection, Staddon and Simmelhag developed a model of behavior in which organisms express a set of species specific interim behaviors from which reinforcement selects one terminal response. This research marked a major turning point for psychology and as a result several lines of research began to coalesce into a major school of evolutionary thought in learning theory.

The conclusion reached by Staddon and Simmelhag that behavior in the superstitious conditioning preparation was biologically organized echoed the conclusion reached by Brown and Jenkins in 1968. Brown and Jenkins proposed that the autoshaped key peck was produced from species-specific response tendencies of the pigeon. Because no explicit control to prevent instrumental conditioning was employed, occurrence of the key peck quite likely was affected by subsequent delivery of the reinforcer. However, even this second facet of autoshaping was qualified by a subsequent study which employed an omission procedure. Williams and Williams (1969) reproduced the Brown and Jenkins design with one important modification, that being the application of an omission contingency. Whereas reinforcement delivery was strictly non-contingent in the previous study, Williams and Williams required that the pigeon not peck for the reinforcer to be delivered. The result was that despite the omission procedure, pigeons persisted in pecking a key when keylight onset predicted food delivery. It proved to be the Pavlovian and not the instrumental contingency which was paramount. This outcome and the many comparable findings in subsequent research make a strictly instrumental view of Pavlovian conditioning difficult to hold. These various findings appear to paint a bleak picture for an instrumental view of Pavlovian conditioning, and suggest that attempts to interpret learning in the Pavlovian preparation using instrumental concepts might best be abandoned.

Nevertheless, there is evidence which has led some (Gormezano & Kehoe, 1973; Gormezano & Moore, 1970; Prokasy, 1965; for example) to propose that an instrumental contingency can be clearly demonstrated in the classic Pavlovian preparation. In the eye-blink or nictitating membrane preparation, response latency and duration have been modified as a direct function of the CS-US delay and US duration. This evidence does not justify abandoning a Pavlovian interpretation for an instrumental interpretation of this or other similar findings. However, it does show that caution is warranted in interpreting SDB as solely Pavlovian.

In this first section, several applications of traditional learning theory were examined for their value in explaining SDB. A strict stimulus substitution explanation was rejected because the behavior expressed in the SDB preparation does not match behavior to the US closely enough to support such a conclusion. Applications of the law of effect also were found wanting since the arbitrariness of behavior which they would demand does not seem to appear.

These various explanations leave unanswered the question of whether SDB is really Pavlovian or instrumental in nature. It may be, too, that any attempt to reduce SDB to a single mechanism is unrealistic, and that a wiser approach would be to pursue other explanations. One such analysis of the nature of conditioning is considered next.

Biological accounts - The Learned Releaser Hypothesis

The Learned Releaser (LR) hypothesis is a direct application to autoshaping of the ethological approach taken by Staddon and Simmelhag to explain the effect of reinforcement. It represents a shift toward the view that the behavior manifest in conditioning is not as arbitrary as had been previously believed. Rather, any conditioning preparation provides a context within which species-specific action patterns may be expressed. Specifically, the freer subjects are to respond without constraint or direction from the preparation, the more likely they are to express species-specific behaviors. This acknowledgement of and attention to species-typical behavior highlights the difference between the traditional psychological approach to the study of animal behavior and the more ethological approach taken here.

It is somewhat difficult to conceptualize exactly what are necessary and sufficient characteristics of this more ethological approach. Just as no simple definition exists for psychology, or more specifically for the psychology of animal behavior, neither does a simple definition exist for ethology. It is even more difficult, therefore, to provide a clear, concise, and complete definition of an ethological approach to the psychology of animal behavior. However, there are at least three important points where the two approaches differ, and where an ethological approach has tended to diverge (although not completely) from other areas of psychology. There are many more which remain to be specified.

One area of divergence is the use of stringent experimental designs to study behavior. While psychology has espoused the use of fairly rigid experimental control in experimental designs, ethology has opted instead for observational designs involving fewer, and occasionally no, controls. Also, concepts of evolution and adaptive fitness have played a central part in specifying the way behavior is viewed by ethologists. Psychologists, on the other hand, have attended more to determinants of the experimental preparation to specify what behavior is to be studied. Finally, perhaps the difference most relevant to this research is the nature of the data that are used to make predictions about behavior. While ethology has relied more on the evolutionary history of the organism to provide information about behavior in a given context, psychology has restricted its view almost completely to the more proximate experimental history of the organism. Even with these differences, however, it has not been the case that the ethological or psychological point of view has been taken to the complete exclusion of the other. The learned releaser hypothesis of Woodruff and Williams (1976) is a good example of an integration of these two views.

The learned releaser hypothesis arose out of research which examined the stimulus-reinforcer relationship in autoshaping. Pigeons were fitted with canulae through which water was delivered directly into the pigeon's beak following illumination of a key light according to a standard autoshaping procedure. Despite making both approach and overt drinking behavior unnecessary with this manipulation, the preparation effectively produced approach to and contact with the key. In order to explain this demonstration of autoshaping, Woodruff and Williams proposed a view of autoshaping that emphasized biological pre-organization of an organism's response to stimuli that signal impending reinforcement.

The researchers compared the production of the autoshaped response with the way that a natural sign releases a fixed action pattern. Several common principles of ethology were seen to apply to this phenomenon. The autoshaped response was observed to comprise not just the URs normally found with a water US, but also several other behaviors as well. The set of behaviors was considered to be the same as that which pigeons display when exposed to water in vivo. The CS was called a learned releaser because it acquired releasing power via conditioning.

Focussing on the behaviors exhibited by their subjects, Woodruff and Williams evaluated both stimulus substitution and surrogation as explanatory principles for their findings, only to reject them as inappropriate for their results. They observed that the development of "...the *complete* set of conditioned behaviors typical of autoshaping with water..." (p. 12, italics added) was better explained by the LR hypothesis, since those behaviors were not identical to the behaviors elicited by a water US. Thus, the signal evoked or released (Lorenz, 1935, cited in Brown, 1975) organized species-specific behavior in the same way as do signals for biologically significant stimuli. The autoshaped response was judged to be both adaptive and appropriate because the behavior normally results in bringing the organism into contact with water. Thus the learned releaser hypothesis proposed a model of behavior in which, via Pavlovian conditioning, a previously neutral stimulus became a releaser for an important species specific action pattern.

The view fits a kind of compromise between opposing explanations of Pavlovian conditioning. Because responding is considered to be organized and adaptive with respect to the reinforcer, natural and conditioned behavior should be similar. This mirrors the suggestion that the Pavlovian CR should resemble the UR. However, by rejecting substitution or surrogation as the response-production mechanism, the more traditional reflexive view of the Pavlovian preparation is traded for a model in which the conditioned behavior can be variable, and yet be sensitive to the signal, the reinforcer, and other factors as well. In this way, SDB is easily seen as preparatory for receiving the US rather than strictly identical to the UR.

A variant of the learned-releaser hypothesis was acknowledged by Jenkins et al. (1978) to provide a better explanation of their results. They argued that while the learned-releaser hypothesis accounted quite well for the topography of the SDB they observed, by itself it did not satisfactorily explain why the behavior was so tightly focussed on and controlled by the signal rather than another aspect of the conditioning environment. [2] Jenkins et al. found particularly compelling the fact that, in virtually all instances of signal-directed responding, behavior was consistently and emphatically directed at the S+ itself, and not at just any stimulus in the enclosure.

Perhaps because Woodruff and Williams were primarily concerned with examining the form of the behavior produced by their preparation, their development of the LR hypothesis reflected too strongly their attention to the components of the unconditional response and of the autoshaped response. As a result, at least one aspect of the autoshaped response, its focus, was not considered sufficiently. Therefore, additional rules must be added to the learned releaser hypothesis before that further characteristic should obtain.

---

[2] It is interesting to note that Williams and Williams (1969) had posed this same question, but did not follow it up.

Jenkins et al. resolved this dilemma by proposing a natural-signals (NS) hypothesis which argued that the experimental paradigm mimicked naturally-occurring conditions necessary and sufficient for the occurrence of food-procuring behavior. They concluded that the S+ did not substitute for food; rather, because it reliably predicted food, it became a surrogate food signal and thus evoked food-procurement behaviors normally directed toward food-availability signals in vivo. In this way, three of the four dogs came to display a variety of SDB, including "...nuzzling, licking, pawing, barking, tailwagging, and frequent lunges at the source" (Jenkins et al., p. 285). These behaviors are all part of the canid action pattern of soliciting food from conspecifics (Fox, 1971), and thus represent a biologically organized species-specific behavior.

Up to this point in the discussion, two basic topics have been presented. First, several traditional attempts to explain the nature of learning in the Pavlovian preparation were discussed and rejected either because of limitations in their ability to explain SDB or because they proposed a response constellation not commonly present in SDB. Then, the learned-releaser hypothesis was presented, and its failure to explain the signal directedness of the behavior was discussed Finally, the NS hypothesis proposed to account for the occurrence of the intense focus of the behavior on the signal

There have been, however, a recent series of studies that offer some intriguing evidence concerning the role of the CS in determining the form of the CR in the Pavlovian preparation. While this research is not central to the questions raised in this research, nevertheless it suggests the existence of another important mechanism which may influence the production and form of SDB.

The Orienting Response Hypothesis

Holland (1977, 1979a, 1979b, 1980a, 1980b) examined the changes in form of the conditioned response which were a function of variation in the conditioned stimulus. As a result of this work, Holland proposed the orienting response (OR) hypothesis. According to this view, conditioned responding has two major components. One component consists of behaviors resulting from enhancement of an unconditioned orienting response via the conditioning preparation. The other component comprises those behaviors directly traceable to elicitation by the US.

The behaviors in each component appeared at different times within the CS interval. For example, Holland (1980a) observed that behavior directed to the food magazine appeared during the last half of the CS interval and was similar to other instances of the same response regardless of the CS which was used. However, behavior observed during the first half of the CS interval was CS-specific. That is, whether the CS was localized or diffuse light, for example, determined the form of the CR expressed to its onset. Similarly, in the earlier studies differences in the relative frequencies of head movement, rearing, and several other responses were observed to relate to whether the CS was one of several different tones or lights.

Two recent articles (Buzsaki, 1982; Davey, Cleland, & Oakley, 1982) suggested that OR behavior such as that of Holland and autoshaped behavior are manifestations of the same mechanism which underlies a larger behavior pattern. Specifically, Buzsaki proposed that the CS-specific behaviors which Holland observed comprise an activity system which allows the organism to locate and then orient and respond appropriately to the US which is signalled by the CS. He also proposed that the CS serves not just to predict the occurrence of the US, but to also identify the location of that delivery. Therefore, it would follow that the form of the CS should affect the form of the CR, since it is the CR which is initially involved in locating and attending to the CS. Further, it follows that behavior should switch from being CS-determined to being US-determined as the end of the CS approaches. It is also possible that at some point in the sequence other factors may operate to determine the form of behavior expressed during the CS. The natural-signal effect and its resulting food-procuring SDB may be one of those factors.

Additional support for this argument is obtained from the observation by Davey et al. (1982) that sign tracking represents what Konorski (1967) called hunger (as opposed to food) CRs. These included increased attention to the CS, which Holland recorded. Also included were arousal, increased motor activity, and vocalization, which Jenkins et al. found. Given these results, it is possible that Holland's OR and Jenkins' SDB are different, possibly sequential, components of a larger behavior pattern each of which has a separate role in determining the form of the CR in this preparation.

B. The Generality of Stimulus Directed Behavior

The ethological approach proposed in this thesis assumes a richness in behavior far beyond the simple CS-CR reflexes traditionally investigated in Pavlovian conditioning. Even when sophisticated applications of the procedure are employed, the response remains fairly simple. For SDB, on the other hand, systems of responding are often discussed, such as food procuring behavior or courtship (see Hearst & Jenkins, 1974, for a detailed discussion). In each case, sets of species-specific behavior have been recorded, suggesting that the SDB preparation involves responding of a more integrated nature.

Despite these arguments to the contrary, however, the possibility remains that the OR and SDB do share some common components, and therefore may be sensitive to the same mechanisms of determination. Perhaps mechanisms which have operated to influence the outcome of a variety of Pavlovian and instrumental studies, such as those specified by Holland, might also operate in SDB preparations. It might be argued further that while Jenkins et al. effectively demonstrated SDB in dogs, their study may lack generality because of an important restriction in design. An increasing amount of experimental evidence, to be discussed shortly, has shown that different signals can produce different action patterns, even though the relationship between the signal and signaled event remains unchanged. If an interaction were to be shown in an extension of the research of Jenkins et al., then a careful reanalysis of the NS hypothesis would be demanded since the NS hypothesis as stated would not adequately account for both the behavior observed by Jenkins et al. and any interaction.

The problem posed by the existence of interactions is not simply that some stimuli control behavior while others do not; rather, for some animals certain stimuli come to control only certain behaviors in certain situations, or at best control behavior differentially well in different situations. Jenkins et al. recognized that their results could be a function of this kind of parametric variation in the experimental paradigm, yet their choice of design may have limited and thus circumscribed a study which easily could have more completely examined signal directed behavior in dogs. It was the problem of specificity, and its potential role in the Jenkins et al. study, which precipitated this research.

Interactions in instrumental and Pavlovian conditioning

In either instrumental or Pavlovian conditioning, three interactions may occur: 1) a signal may interact with a response, 2) a signal may interact with a reinforcer, or 3) a response may interact with a reinforcer (see Shettleworth, 1972, 1979; or LoLordo, 1979, for a more detailed discussion). As is the case with any interaction, the effect produced by the joint operation of the factors is not predictable from the independent operation of those factors. In the case of the three interactions specified here, the behavior resulting from the combined operation of stimuli, responses, and reinforcers changes depending upon which particular stimulus, response and reinforcer are employed. Research in which each type of interaction has occurred is common, and examples of each type are described below.

An interaction of stimulus with response was shown in a study by LoLordo, McMillan, and Riley (1974). Examining the role of both the stimulus and the response in autoshaping, LoLordo et al. superimposed Pavlovian training over either instrumentally reinforced pecking or treadle pressing. Specifically, interspersed throughout periods of instrumental responding were Pavlovian trials in which either of two CS's preceded automatic delivery of food. The authors found that when the CS was a visual cue, pecking was facilitated but treadle pressing was suppressed. Conversely, when the CS was an auditory cue, no consistent effects were noted.

An interaction of response with reinforcement occurred in an earlier study of behavioral contrast (Hemmes, 1973). Pigeons were trained on a multiple variable interval-variable interval schedule either to peck a key or press a treadle. When one of the two schedule components was subsequently switched to extinction, birds trained to key peck exhibited behavioral contrast as predicted, but birds trained to press the treadle did not. Further, when the treadle pressers were trained subsequently to key peck, they displayed behavioral contrast in the same manner as did birds which were trained only to peck.

Finally, in two other studies (Foree and LoLordo, 1973; and LoLordo and Furrow, 1976), a stimulus-reinforcer interaction was clearly demonstrated. In that research, auditory and visual elements of compound cues controlled responding for shock avoidance and food acquisition, respectively.

These studies of interactions are important because they show that simple application of instrumental or Pavlovian contingencies may demand more than a simple instrumental or Pavlovian interpretation of the outcome. Similarly, should it result that interactions appear in SDB studies, then a simple evolutionary interpretation of those results must pay some attention to other causal agents. The main piece of evidence that this could be of some concern came from studies of the role that stimulus quality played in performance of a simple motor response by dogs.

Interactions involving stimulus type and problem type

Dobrzecka, Szwejkowska, and Konorski (1966) and Lawicka (1964) found that not just the modality of the stimulus but other aspects such as its quality and method of presentation affected the nature of the observed response. Lawicka (1964) examined discriminated go-right/go-left and go/no-go responding by dogs in an open field. Two tones from one location or one tone from two locations served as the discriminative cues for both types of responding, creating a 2X2 design of cue condition and response problem. A strong interaction between response and cue was found: dogs easily learned the go/no-go response when two tones from one location varied in pitch, or the right-left discrimination when one tone varied in location. However, the alternate combinations of task and cue resulted in little better than chance performance after numerous trials.

Dobrzecka et al. (1966) examined interactions using a slightly modified procedure. In this experiment, go/no-go and right/left (R-L) differentiation involved movement of one or another foreleg rather than the whole dog. Discriminative cues were constructed from an auditory element [buzzer (B) or metronome (M)] and a position element [anterior (a) or posterior (p)], with each element balanced across subjects (Ba, Bp, Ma, or Mp). As an example of the problem presented in phase 1, a buzzer from in front (Ba) and a metronome from the rear (Mp) signaled the appropriate

R-L differential responses required of a subject for reinforcement. In phase 2, one of the cues (e.g., Ba) signaled "go" (lift foreleg) while another (e.g., Mp) signaled "no-go" (don't lift foreleg). In both phases, control of responding was tested with a probe stimulus; that is, nonreinforced presentations of a test cue were interspersed with reinforced trials using the training cue. The test consisted of relocating the auditory cue – from front to rear, or vice versa – and observing whether the dogs' responses were appropriate to the auditory element or the position element of the test cue. In the first phase, Dobrzecka et al. (1966) found that for dogs responding with a R-L differentiation the position of the cue and not its quality controlled the discrimination. In the second phase, they confirmed Lawicka's (1964) finding that the quality of the cue and not its location exhibited overwhelming (although not complete) control over go/no-go behavior.

Table 1 displays the results of these two studies in a much abridged form. For the experiments defined by the "good" diagonal, discrimination of the reinforcement contingency, and subsequent appropriate responding, occurred after only a few trials and with a high degree of accuracy. For those defined by the "poor" diagonal, on the other hand, criterion performance of the discrimination was achieved with great difficulty after hundreds of trials, and for some dogs the discrimination was never acquired. The nature of this outcome will have some important implications for

Table 1

Summary of Performance in Two Response Problems from Studies on Cue Quality and Location

Problem Type	Cue Condition Quality	 Location
Go/No-Go	Good	Poor
R-L Diff.	Poor	Good

Adapted from Dobrzecka et al. (1966) and Lawicka (1964) generalizing the research of Jenkins et al. to broader designs.

Summary

Interactions have occurred frequently in studies of learning, two of which demonstrated important stimulus-response interactions. Those studies, by Lawicka (1964) and Dobrzecka et al. (1966), are of special interest. They found that the apparent ease with which dogs acquired go/no-go and R-L differential responding varied directly as a function of the nature of the cue signaling the appropriate behavior. In particular, go/no-go responding developed easily when two different signals came from the same location but only with great difficulty when a single cue came from two positions. These studies have definite implications for the preparation employed by Jenkins et al. (1978). In that design, a single compound cue was presented from the right or left side of the enclosure, and dogs were required to learn a go/no-go response. Reference to Table 1 shows this to be the poorer of the two possible go/no-go tasks explored by Lawicka and by Dobrzecka et al. The implication is that had Jenkins et al. used either a single source or a R-L differentiation, different results might have been obtained.

C. The assessment of interactions in SDB

General designs

The present research attempted to address the possibility that the interactions which were demonstrated in

Konorski's lab might also obtain in an extension of the design employed by Jenkins et al. Two experiments were run to assess the role that stimulus attributes might play in the control of action patterns in dogs. The first experiment presented a go/no-go problem to two pairs of dogs. For two of the dogs, a single compound was presented from the right on some trials, and from the left on the remainder, with presentation from one side (S+) but not the other (S-) signaling food delivery at a central feeder. For the remaining two dogs, two compounds were presented from one side only. For each dog, one of the compounds (S+) but not the other (S-) predicted food at a single feeder. A second experiment, also involving two pairs of dogs, employed these same cue conditions, but the cues predicted food delivery at one (S1+) or the other (S2+) of two locations. The first problem is displayed in the top half of Table 2. It was labelled the food-availability problem. The second, called the food-location problem, is displayed in the lower half of the table. This 2X2 cross of cue and location thus replicated Lawicka's (1964) cue-problem combination within the Jenkins et al. (1978) preparation. This design was employed because if "the outcome probably depends on the spatial arrangement [and] type of CS" (p. 275) as Jenkins et al. (1978) suggested, and if the interaction demonstrated by Lawicka (1964) were to hold here also, then it should be possible to differentiate the signal directed behavior in one cue condition from that in another, and that in one problem from that in another.

Hypothesized results

Although it may be anticipated that cue type and problem type will influence signal directed behavior, less clear is the specific form in which such an influence might be manifest. In advance of any data from Jenkins et al. (1978) it might have been proposed that the performance pattern in Lawicka (1964) would be reproduced directly. That is, signal directed behavior would develop easily in problems along the "good" diagonal in Table 1, but with difficulty, if at all, along the "poor" diagonal. Such a direct extention of effect is unlikely, however, given that Jenkins et al. (1978) demonstrated signal directed behavior in the problem in the upper right quadrant of Table 1, on the "poor" diagonal.

Four hypotheses which anticipate an interaction between stimulus condition and task might be envisioned. All assume that the Jenkins et al. (1978) demonstration is reliable and take it as a focal point for other comparisons. Two hypotheses assume signal directed behavior to be a function of whether or not dogs solve the go/no-go and R-L discriminations and learn to respond correctly, and whether they do so efficiently. The other two hypotheses assume signal directed behavior to be functionally independent of food acquisition behavior (FAB), requiring only the presence of, and sensitivity to, a CS-US contingency.

2a. Hypotheses assuming a relation between acquisition of discriminated responding and SDB.

One possible outcome is that the development of SDB would be consistent with the results of Lawicka (1964). According to this view, the pattern of go/no-go and R-L differentiation responding in FAB would be manifested in SDB. A response production rule or threshold might be required to explain the lack of responding under particular cue conditions. According to this view, acquisition of SDB might be a function of first learning the CS-US relationship and approaching the feeder, and then generalizing attributes of the US to the CS so that SDB would appear. In this way, first FAB would appear and then SDB would follow. As long as the CS-US association were not formed, FAB (and its associated SDB) would not appear.

Another possibility is that exhibiting SDB is conditional upon the difficulty of acquiring appropriate FAB. Since a trial ceases with delivery of the reinforcer, easily acquired FAB may preempt the display of SDB. Accordingly, the more difficult food acquisition problem identified by Lawicka (1964) should facilitate the display of signal directed behavior, and easier problem should block it. The outcome for SDB would thus be the reverse of that shown in Table 1, with FAB supplanting the display of SDB. Alternatively, both problems may produce signal directed behavior, with the relative position of SDB in a problem the reverse of that for food acquisition behavior. In this case, FAB is assumed to inhibit but not block SDB, so that it will still be observed but at lower frequencies or intensities. That such a result is feasible has been suggested recently in a theoretical paper by Zajonc (1980). He argued that for human behavior, at least, affective and cognitive judgements can be acquired separately and at different rates. If such dynamics exist for animal behavior, then quickly acquiring food acquisition behavior may effectively circumvent signal directed behavior. Such a condition could easily exist in problems of the type Lawicka (1964) discussed.

2b. Hypotheses assuming independence of FAB and SDB.

The remaining two outcomes assume that SDB is independent of food acquisition behavior. That is, whether FAB is acquired and expressed is not necessarily relevant to whether SDB is obtained. Accordingly, Jenkins et al. found signal directed behavior using a problem in which Lawicka (1964) did not find food acquisition behavior. The first of these two hypotheses assumes that real differences exist with respect to how SDB is acquired in each problem. The same learning mechanisms which underlie FAB underlie SDB, so that the two develop in much the same manner. Therefore, not only do both types of food acquisition behavior develop at different rates, so too do both types of signal directed behavior. However, this possibility can be rejected because, if FAB and SDB are equivalent and concurrent, Jenkins et al. should not have found SDB in a condition where Lawicka did not find FAB.

The fourth possibility simply considers signal directed behavior and food acquisition behavior to be equal, but neither equivalent nor interdependent aspects of the preparation. Whether or not a subject exhibits signal directed behavior is determined by the experimental conditions in force. Therefore, whether a subject also acquires appropriate food acquisition behavior is really not relevant. The important question is whether the necessary conditions are in effect to support SDB in either or both of the food acquisition problems. Further, an interaction might be expected if those conditions reflect the cue-response conditions employed in Lawicka (1964).

Finally, a close examination of the procedure suggests that regardless of the food acquisition problem presented, all cues should support signal directed behavior since the correlation between any cue and food delivery is perfect. The procedure has embedded in it the necessary conditions for easily displaying SDB to both cues. Therefore, neither differential signal directed behavior nor an interaction should be apparent under this hypothesis, with both cue conditions showing signal directed behavior in both food-acquisition problems. That this last outcome is possible is at least intuitively logical from an adaptive viewpoint, since reliable signals for food should evoke food acquisition behavior regardless of the characteristics of that signal. For an animal which is foraging, the cost of ignoring food that is most certainly there is much higher than the cost of looking for food that is only rarely present.

The primary purpose of this introduction has been to introduce and discuss two important aspects of animal behavior. One of these aspects was signal directed behavior, the strong focus behavior may have on stimuli predicting the delivery of reinforcers. The other aspect was the potential role of cue-task interactions in determining the outcome of the Pavlovian preparation. It has been suggested that traditional accounts of learning are inadequate to explain SDB, but that many of the same mechanisms may operate to affect SDB. It also has been suggested that the Jenkins et al. preparation may be extended to encompass a more complex design in which a stimulus-task interaction might be found.

The next section describes the general methodology common to the two studies which were proposed to explore this possibility. Then, Experiment 1 will be presented, in which the food availability problem was employed. In that design, two signals (S+ and S-) indicated whether or not food was to be delivered via a single feeder. Finally, Experiment 2, the food location problem, will be described. In that study, two stimuli (S1+ and S2+) were used to signal the trial-by-trial availability of the reinforcer from one or the other of the two feeders.

II. General Method

A. Subjects

This study used eight dogs as subjects. Since no details were given in either of the earlier studies (Dobrzecka et al., 1966; or Lawicka, 1964) and only mongrel dogs were specified by Jenkins et al. (1978), mongrel dogs were used in the present study. Animals with unspecified pre-experimental histories were obtained from the University of Alberta kennels in Ellerslie, Alberta. All subjects were female, approximately 2 years old, weighing between 15-20 kg. Individual life histories prior to acquisition by the kennels are unknown. They were housed in the same room as the experimental apparatus and exposed to the auditory cues used in all studies, but were unable to observe events within the enclosure. Standard housing consisted of an elevated cage approximately one by two meters in floor space and two meters high, with a solid fiberglas floor with a drain. Each cage also contained the necessary food and water dishes, and a bench approximately 30 (W) by 30 (H) by 100 (L) centimeters. Lighting was maintained on a 12-hour light-dark cycle set on at 8:00 a.m.

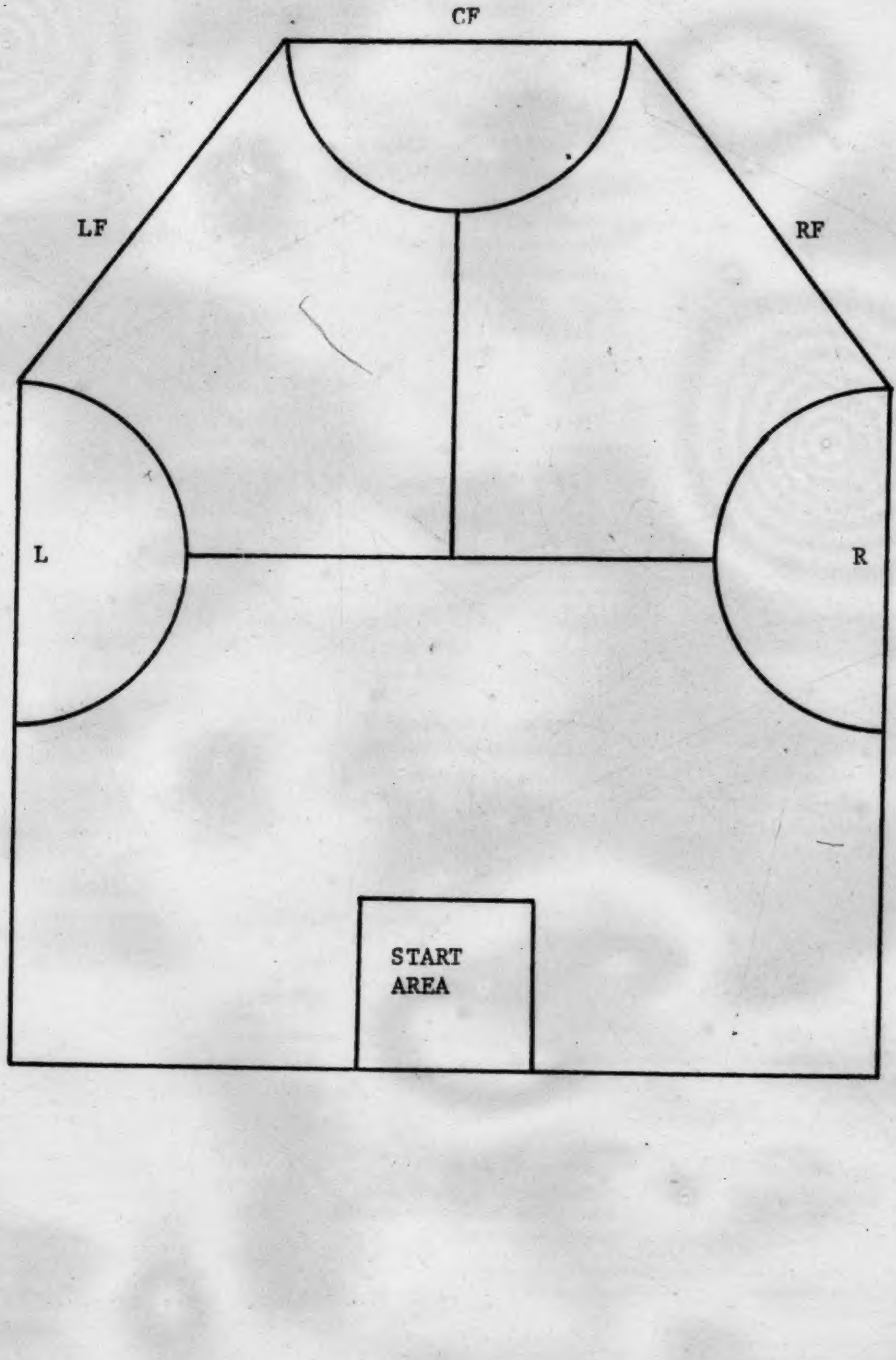
B. Apparatus

The experimental enclosure was constructed to replicate Jenkins et al. (1978) in all essential details, with alterations described below. A diagram of the apparatus is shown in Figure 1. Walls 1.2 meters high were constructed of 7 mm plywood; areas were marked on the floor using black plastic tape; and a black rubber mat was placed in the position marked by "Start Area" on the diagram. Two stimulus sources, marked R and L in the figure, were constructed from wood, and each contained a 40-watt clear bulb and the hardware through which the auditory cues were delivered. They protruded approximately 10 cm into the enclosure at a height of 25 cm. Visual stimuli were two 10 cm X 10 cm translucent "milkglass" slides per source, illuminated from behind by the 40-watt bulbs, and carrying one of two patterns: horizontal or vertical black stripes. To complete the auditory-visual compound, tones and buzzers were used. During Experiment 1, tones were provided by two, 28-volt Sonalert tone generators, while the buzzers were a standard six-volt variety. The use of two Sonalert tone generators and two buzzers in the first experiment introduced some spurious variation into the stimuli. Therefore, prior to beginning the second experiment, one tone generator and one buzzer were tape recorded in order to produce identical intra-modal sounds. These stimuli were then presented via 8.5 cm speakers which were mounted inside the stimulus sources.

A manual food delivery system was constructed from 10 cm plastic pipe, aluminum deflectors, and plastic feeder dishes secured to the floor at the proper delivery location. Lengths of plastic pipe were attached to the outside of the

Figure 1. A schematic diagram of the experimental enclosure. The areas were marked off on the floor using black tape. The following codes describe various other features:

a. L and R designate stimulus sources,
b. LF, CF, and RF designate feeders, and
c. S designates the start area.


CF
LF
RF
L
R
START
AREA

enclosure at the locations marked by RF, CF, and LF on the diagram in Figure 1. A 10 cm by 10 cm aluminium deflector was attached to the inside of the enclosure over the opening in the wall through which the reinforcer was to be delivered, with approximately 5 cm clearance between the deflector and the wall. This served to deflect the piece of weiner down into the feeder dish. Plastic plates 15 cm in diameter were secured to the floor of the enclosure immediately below the openings and deflector plates. The three pipes converged at the upper end of the enclosure so that easy access was possible from the position taken by the experimenter.

Throughout each session of training, the experimenter was positioned at a point outside the enclosure at the end opposite the starting mat. Full view of the enclosure was possible, as was access to the plastic pipes used to deliver the USs. From this position, the experimenter monitored the behavior of the dog currently in the enclosure.

The reliability of the observer's ratings was tested in a subsequent session in which samples of trials were taken from video tapes of the second experiment and then observed by the experimenter and two independent raters. Those procedures and the results of the inter-rater comparisons are described in Appendix 2.

C. Procedure

Feeding schedule

Dogs had 24-hour free access to water. Food was removed by animal care personnel prior to cage cleaning at approximately 8:00 a.m. on conditioning days, and withheld until returned by the experimeter following each experimental session. The total time between removal and return varied for different dogs, but amounted at most to 4-5 hours. From the end of the day's session until the morning of the next training session, dogs had free access to standard lab chow.

Reinforcement procedures

The reinforcer used in all sessions consisted of a small piece of weiner. The size of each piece was approximately equal within experiments, but the number of individual pieces was determined by the number of trials to be reinforced during a session. The number of weiners used per session (four in the food-availability problem and five in the food-location problem) was set in an effort to keep the overall magnitude of reinforcement approximately equal to reduce the risk of differential satiation during a session. Each reinforcer was delivered manually by the experimenter so that it was made available to the dogs as close to CS termination as possible. Because the reinforcers were delivered manually, there was some unsystematic variation between CS offset and US delivery.

Observation procedures

Behavior was monitored at all times by the experimenter from the position outside the enclosure. Locations were assigned using the dogs' front paws as reference. While Jenkins et al. (1978) used the dogs' noses, using the paws appeared to be a less judgemental, and therefore more reliable, method. Recorded on each trial were position of the dog at the beginning of the trial, response to the stimulus following onset, and behavior directed toward the source(s), the food slot(s) or plate(s), or the experimenter. A rating scale was developed by the experimenter based on the descriptions provided by Jenkins et al. of the behavior recorded in that study. Responses were generally recorded with up to three components. The primary component was a response type, such as approach, orient, and wag. In addition, a location code reflecting the nine areas of the enclosure was included for responses in which a position was relevant (e.g., approach to a particular feeder, standing or lying down, etc.), and one (or more) of 10 modifiers. These modifiers indicated a target for the response (e.g., the feeder slot), a body part, or some other quality not covered by the first two categories. A list of these three components is provided as Appendix 1. In addition, a description of the criteria for classifying a trial as including SDB has been included.

Habituation

The general habituation procedure of Jenkins et al. (1978) was followed except that the nature of the nonreinforced stimulus presentations during the last session depended upon the first experimental condition to which the dog was assigned. Six sessions, each 10 minutes in duration, were used to habituate the animals to the enclosure. Prior to each habituation session, one half-section of wiener was placed in the food plate. In the last habituation session, four 10-sec presentations of the compound stimuli were given, unaccompanied by food delivery, to observe unconditioned responses to the stimuli. Dogs in the stimulus quality condition described below received two presentations each of the two cues from one source. Dogs in the stimulus location condition received two presentations of the one cue from each of two locations. The cues were presented in a counterbalanced order one minute apart beginning at 6:30 of each last session and on the half-minute thereafter to the end of the session.

Training

The overall procedural design is illustrated in Table 2. All dogs served in both stimulus conditions of the experiment in which they were subjects. For the four dogs within an experiment, one pair underwent training with stimulus position as the relevant cue and then shifted to the problem with stimulus quality as relevant. The other pair reversed this sequence. The experimental conditions in

Table 2

Four conditions of training resulting from the factorial combination of two levels of problem type (food availability and food location) with two levels of relevant cue (stimulus position and stimulus quality)

	Experiment 1			Experiment 2		
	Food Availability Problem			*Food Location Problem*		
	Stimulus Quality	Stimulus Site	Food Site	Stimulus Quality	Stimulus Site	Food Site
Stimulus Position as Relevant Cue	HT	R	CF	HT	R	RF
	HT	L	None	HT	L	LF
	VB	L	CF	VB	L	RF
	VB	R	None	VB	R	LF
Stimulus Quality as Relevant Cue	VB	R	CF	VB	R	RF
	HT	R	None	HT	R	LF
	HT	L	CF	HT	L	RF
	VB	L	None	VB	L	LF

Note: T=Tone, B=Buzzer, H=Horizontal stripes, V=Vertical stripes, L=Left source, R=Right source, LF=Left feeder, RF=Right feeder, CF=Center feeder.

Phase 2 were assigned so that any bias from the transfer of conditioned excitation or inhibition in Phase 1 should act against the experimental hypothesis. For example, if a compound from the right were reinforced in Phase 1 (CS1-R+), then in Phase 2 the right source was used, with the new compound cue reinforced and the old, previously reinforced compound cue not reinforced (R-CS1-, R-CS2+). Alternatively, the new reinforced cue might have been the old non-reinforced cue (CS1-R+ becomes L-CS2+).

Thus, each assignment necessitated ultimately reversing conditioning from the first phase so that signal directed behavior could be expressed. Specific cue conditions for each dog are displayed in Table 3. Ten sessions of discrimination training were run. Each session consisted of a random sequence of 20 presentations each of the S+ and the S-, with the restrictions that 10 presentations of the S+ occurred in each set of 20 trials, and runs of no longer than three were permitted. The stimulus had a 10-second duration, with a minimum interstimulus interval (ITI) of 50 seconds established by extending the ISI gradually from 30 seconds over the course of the first few sessions.

Initially, two criteria had to be met before a stimulus would be presented. The first was that the minimum time between the offset of one S and the onset of the next was 50 seconds. In addition, the dog had to be in contact with the mat immediately preceding stimulus onset. If the dog failed to return to or stay in the start area and maintain contact

Table 3

Assignment Conditions by Phase

Problem	Dog	Phase 1		Phase 2	
		Stimulus Condition	Parameters	Stimulus Condition	Parameters
Food Availability Problem (Exp 1)	Gladys	Quality	(L) HT+ VB-	Location	(VB) R+ L-
	Gretchen	Quality	(R) VB+ HT-	Location	(HT) R+ L-
	Cleo	Location	(VB) L+ R-	Quality	(L) HT+ VB-
	Minnie	Location	(HT) R+ L-	Quality	(R) VB+ HT-
Food Location Problem (Exp 2)	Kelbi	Quality	(R) VB-R HT-L	Location	(HT) R-R L-L
	Dingo	Quality	(L) HT-R VB-L	Location	(VB) R-L L-R
	Woosha	Location	(HT) R-R L-L	Quality	(R) VB-R HT-L
	Flo	Location	(VB) L-R R-L	Quality	(L) HT-R VB-L

Note: Items in parentheses are stimulus parameters which are held constant across trials within a phase; R and L indicate feeder locations; + = reinforced; - = not reinforced; V = vertical; H = horizontal; B = buzzer; T = tone.

with the mat, the stimulus was delayed until these criteria had been met. Finally, some pre-stimulus behaviors, such as grooming or sniffing the door or mat, also caused postponement of stimulus onset even if contact with the mat was maintained.

For the first few subjects, the second criterion had been more strict. The dog had to be completely on the mat, as had subjects in Jenkins et al. (1978). Two problems quickly became apparent. One was that this criterion would have been very difficult to maintain. Frequently, attempting to enforce it interfered seriously with training. The second point to become apparent was that being on the mat was necessary only to ensure that any behaviors directed toward the signal be discriminable from behavior directed to a feeder. Therefore, the dogs' position at the beginning of a trial was allowed to vary so long as some contact with the mat was maintained. In some cases, this meant sitting on the mat with the front paws on the floor, or lying half on the mat either to the front of the enclosure or to the side opposite the source of the next stimulus.

III. Experiment 1: The food-availability problem

In this experiment, the preparation involved presenting an S+ which signalled US delivery and an S- which signalled no delivery. Procedures specific to this problem are discussed below. Four dogs underwent training in this research.

A. Procedure

Reinforcers were delivered manually by the experimenter to a central feeder (CF) at the end of the enclosure opposite the starting position (see Fig. 1). For each dog, four wieners were cut into five approximately equal sized pieces to produce 20 portions. These portions served as the reinforcers during training, each dog receiving equal numbers of pieces. The training procedures employed in this problem resulted in 50% of the trials terminating with US delivery.

Stimulus position as relevant cue

In this problem, the location from which the CS eminated was the relevant attribute; in all presentations, CS quality was held constant. For two dogs, reinforcement was delivered following presentation of the CS from the right source. For two other dogs, reinforcement followed presentation of the CS from the left source. The CS consisted of an auditory-visual compound constructed with horizontal (H) or vertical (V) stripes on translucent milkglass, and a tone (T) or buzzer (B). One dog from each pair was trained with VB, while the other was trained with

HT. To reiterate the design in Table 2, the four specific conditions for reinforcement were:

Dog 1) HT:R+L-
Dog 2) HT:R-L+
Dog 3) VB:R+L-
Dog 4) VB:R-L+.

Stimulus quality as relevant cue

In this problem, the CS location was held constant for a given subject, with the quality of the CS becoming the relevant attribute. Only one stimulus site was used with a given dog. Two dogs received exposure to site R, while the other two were trained with site L. For one dog in each pair, HT signalled food availability. For the remaining dog in each pair, VB predicted US delivery. To summarize the design, the four conditions were:

Dog 1) R:VB+HT-
Dog 2) R:VB-HT+
Dog 3) L:VB+HT-
Dog 4) L:VB-HT+.

Special training

Enforcement of the planned procedure was precluded by individual reactions to the CS during the last session of habituation. It was necessary for several of the dogs in this study to receive special training to overcome adverse reaction to the CS presentations, or to create the necessary behavioral substrate against which SDB might be observed. Three of the four dogs received special attention.

Gretchen did not receive any special training during Experiment 1 in either the first or second phase of the study.

Gladys received some instrumental training during Day 2 of Phase 1 to move her to the back of the enclosure. The training consisted of delivering small pieces of weiner, equal to approximately one quarter of the regular US, as an instrumental reinforcer for approaching and maintaining brief contact with the mat. In this way, Gladys was first trained to remain in the rear of the enclosure prior to implementing the formal procedure.

Minnie required extensive special training. During training, a fixed posture occurred, characterized by a lowering of the head to the left for minutes at a time following US delivery. This position was adopted immediately after consuming the piece of wiener delivered on an S+ trial, upon return to the mat, or at some intermediate point. Two modifications of the procedure to overcome this behavior were undertaken. First, the requirement that the dog maintain contact with the mat was relaxed, and a strict Pavlovian procedure was employed in the hope that the Pavlovian training would help to overcome the inappropriate behavior. A reinforcer was delivered at the end of a standard 50-sec ITI and 10-sec stimulus regardless of her position during the ITI. This technique was unsuccessful, since Minnie very quickly learned to lie at the front of the enclosure with her head proximate to the feeder dish. The second modification involved attempting to induce Minnie to return to the mat by delivering a prompt as described above for Gladys, to induce movement back onto the mat in the Start Area. After several sessions of this intervention, Minnie began to respond appropriately.

Cleo received similar prompts as a result of her. movement to the line dividing the front and back areas of the enclosure. During Day 5 of Phase 2, Cleo again had to be shaped back onto the mat using a standard instrumental procedure in which standing on the mat produced a piece of wiener in the food slot. After ten trials of instrumental training, the experimental procedures were re-established for the duration of the study.

B. Results and Discussion

Habituation

During initial trials in the enclosure, all four dogs showed some caution and heightened attentiveness, but this behavior habituated quickly, and soon disappeared. No signs of fear were evident following the very early parts of Session 1. By the fifth habituation session, they entered the enclosure and ran directly to the plate containing the weiner. During the remainder of the habituation sessions the dogs explored the enclosure, sniffing the floor, drain, stimulus sources, food delivery slot, and plate. During the latter habituation sessions, the dogs frequently defecated and urinated in the enclosure, but there were no signs that the acts were fear produced. During Session 6, there occurred nonreinforced presentations of the stimuli which were to be used subsequently in training. The presentations elicited startle responses, some cowering in Gretchen and Minnie, and orienting and exploring in all dogs. In no case did either the S+ or the S- evoke any specific approach to either the stimulus sources or the feeder slots.

Because subjects served in both stimulus conditions of a given problem, the stimulus condition and phase are reversed for some subjects. Results have been discussed by stimulus condition; therefore, in some cases second-phase results are described before the first-phase results for an animal.

Stimulus-quality condition

Gladys (Phase 1): Virtually all of the behavior in this experimental condition was goal directed (Boakes, 1977). The few responses containing any signal-directed components differed from the others only in that the path taken to the front of the enclosure arced toward the S+. The one consistent change in behavior was that approach to the front of the enclosure occurred progressively earlier in the 10-second S+ over trials. Initially, approach began when the US was delivered to the food plate. Shortly thereafter, responding occurred at S+ offset. On Day 5, two responses occurred at eight seconds of the S+, with the rest at its termination. On Day 6, and each day thereafter, approach to the feeder began earlier and earlier in the S+ until, by

Day 10, all responses to S+ occurred during the first five seconds of the stimulus. At this point, the common response consisted of sitting or lying on the mat during the ITI, orienting to the source when the stimulus came on, and either remaining on the mat (S- trials) or moving almost immediately to the front of the enclosure (S+ trials). Only a weak form of signal directed behavior was observed in the form of a deflection of the path taken to get to the goal.

Gretchen (Phase 1): Even less of this dog's behavior was signal directed in this condition. On Day 7, only one goal approach occurred during the first half of the S+. Other goal approaches, totalling ten and nine respectively, occurred during the last half of the CS or to the US. There was little change in response patterns over the last three sessions. Like Gladys, virtually all behavior was focused on the slot, with orienting to the source observed once, and approach to it observed one additional time toward the end of 200 trials. The stereotyped response began sometimes early and sometimes late in the 10-second S+. Specifically, it consisted of the following sequence: orienting first to the source and then to the food slot at stimulus onset, and then orienting toward and approach to the food slot after a variable interval. The path to the front was direct, with no deflection toward the source of the S+.

Cleo (Phase 2): This condition was experienced as the second phase of training. Beginning early in this phase (Trial 20, Session 1), discriminative responding developed, with SDB appearing by the end of the first day. Included in the behavior were leaps or pounces at the source and nose contacts with the slide. Because the behavior had been displayed in the first phase, it will be described more completely in the next section. However, two trends developed over the course of the training which merit some mention. First, the leaps, which previously had been an integral part of most responses to S+, began to disappear from the response by about Session 4 or 5. Subsequently, they occurred rarely. The nose touch occurred with decreasing frequency, also; however, compared to leaping it was both more persistent by one or two sessions, continuing to occur through Session 6 or 7, and relatively more frequent. By the end of this phase, approach to the source at S+ onset was still occurring, but the heightened activity exhibited in the first phase was only rarely observed.

Minnie (Phase 2): Behavior on S+ trials was goal directed from Day 2. It was not until Day 6 that facing the source of the S+ from the front of the enclosure was observed. At no time during the training did approach during the S+ occur. In fact, when any arc in the goal response occurred, it was away from the source. As in the first phase, a stereotyped S- response occurred frequently. Beginning on Day 2, tail chasing and/or biting was common on S- trials. This response pattern persisted throughout 10 sessions of training.

The results of the stimulus-quality condition of the food-availability problem are displayed in Figure 2a. The data reported are the percent of trials per session in which at least one incidence of SDB was recorded. Only one dog, Cleo, consistently displayed SDB in this training, which was Phase 2. Beginning with session 4, SDB was observed on all trials. The peak at session 6 for Minnie reflects only orienting to the source from the front of the enclosure.

Stimulus-location condition

Cleo (Phase 1): Anticipatory responding during the US appeared on the first day of training as approach to the feeder, but no discrimination between S+ and S- was apparent for the first part of the day. Signal directed behavior began to appear on Day 2, with approaches to the S+ dominating the S+ behavior pattern. By Day 3, immediate approach to the S+ source appeared, followed by holding that position for eight to nine seconds, and then by terminal approach to the front of the enclosure just prior to US delivery. During Day 5 the most active components of SDB developed. Approach to the source occurred immediately; also included were the tail wag; leap/pounce; and crouch, facing the source with front legs extended, head lowered, and rear raised, in a classic play soliciting posture. This general pattern of behavior dominated responding to S+ throughout the remainder of Phase 1 training and during the first half of Phase 2 training. Two very interesting, non-consummatory behaviors developed during training, and were regularly although infrequently displayed in both Phase 1 and Phase 2. First, a forced yawn or gape developed, which was expressed on both S+ and S- trials. It usually replaced approach to the source on S- trials or appeared along with approach to the source on S+ trials. Tail-chasing also was observed, but less freqeuntly than for previous subjects.

Minnie (Phase 1): Because of the problem mentioned earlier under 'Special Training' with the tendency to assume a fixed posture during training, not much in the way of either signal- or goal-directed behavior was exhibited during the first five days, except for approaches to the feeder upon delivery of the US. One anticipatory goal approach occurred during Day 5, but during the next two days of training, similar approaches occurred on S- trials. During the last three days of training, some organization and consistency developed, so that on Day 8 orientiing toward the S+ from the front of the enclosure was observed, and on Day 10 goal approaches were deflected toward the side of the enclosure from which S+ originated.

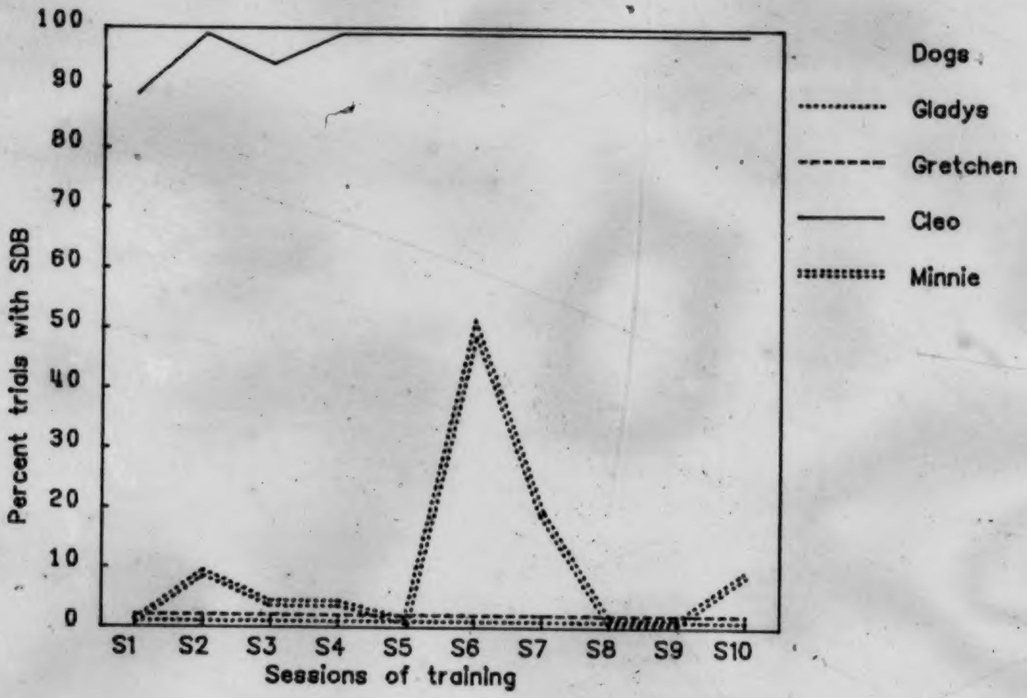
Gladys (Phase 2): The movement of the response to the earlier part of the S+ interval begun in Phase 1 continued during early sessions, so that by Day 3 immediate responding to S+ onset was characteristic. On this day, regular signal directed behavior began to occur, though it was a weaker form. The usual response began with an approach to the front of the enclosure at stimulus onset following an arcing path nearer the source of S+, with orienting to the source continuing from onset to approach termination. On the final few days of training, looking back at the source from the front of the enclosure was observed, but only four times in four days. Goal approach behavior, however, displayed a strong signal directed character. Many of the goal approaches were characterized by strong arcs toward the source of the S+, but none of them included stopping on the way to the goal as did those in Cleo. The typical response began at S+ onset, and terminated with the dog standing very close to the feeder slot, frequently with her nose inside the slot itself.

Gretchen (Phase 2): Some anticipatory responses began in the last half of Day 1 training. Over the course of the remaining training, responding began earlier in the S+ each day so that Day 10 responses were started at 4-6 seconds of the S+, some 2-4 seconds earlier than on Day 1. Only one feeder approach, on Day 7, was an arcing approach to S+; otherwise no signal directed behavior occurred.

Figure 2b displays the results of the training in the stimulus-location condition of the food-availability problem. As in the other condition, no SDB was recorded for Minnie and Gretchen. The data displayed for Cleo shows a rapid development of SDB in this condition (Phase 1) which was carried over into the stimulus-quality condition (Phase 2) displayed in Figure 1. The incidence of SDB reached 100% by the fifth session. For Gladys, similar results were obtained. SDB occurred on 90% to 100% of the trials in Sessions 4 to 10. This level of responding represents a dramatic change from the responding observed in the first phase.

Figure 2a. Percent of trials per session in which SDB occurred for the stimulus-quality condition of the food-availability problem.

Figure 2b. Percent of trials per session in which SDB occurred for the stimulus-location condition of the food-availability problem.


100
90
80
70
60
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10
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Percent trials with SDB
S1
S2
S3
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S7
S8
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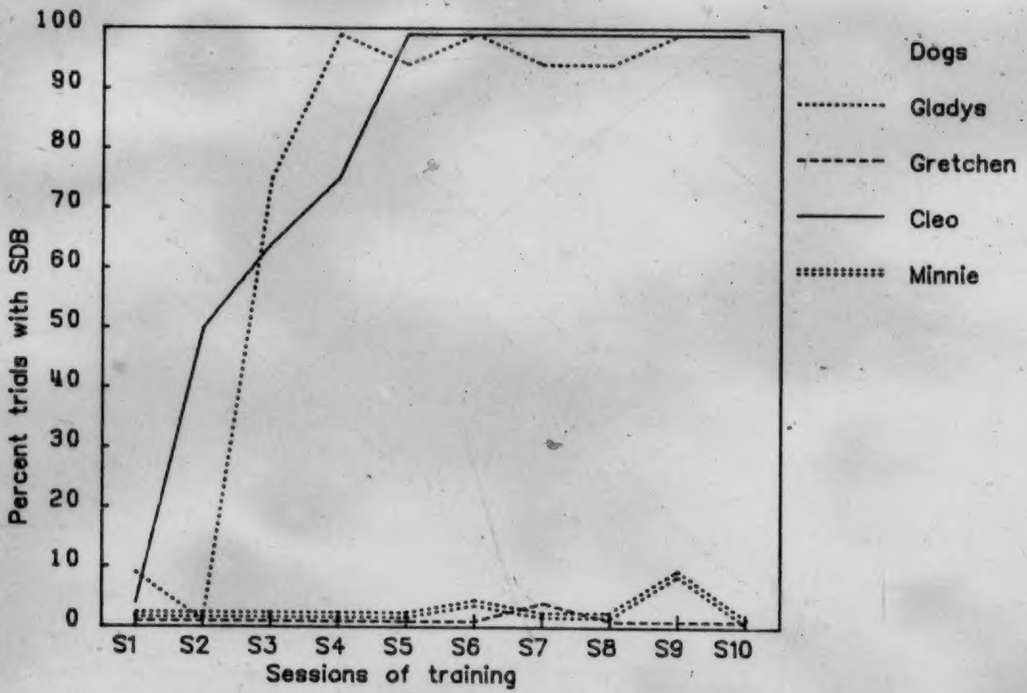
S10
Sessions of training
Dogs
Gladys
Gretchen
Cleo
Minnie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Percent trials with SDB
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
Sessions of training
Dogs
Gladys
Gretchen
Cleo
Minnie

Summary

The behavior of each dog in each condition showed little of the desired consistency within a problem, fluctuating between being signal-oriented on one trial and goal-oriented on another. When SDB did occur, it was highly consistent from one time to the next for a given dog. Once it appeared, it changed little over trials except to be attenuated in intensity. Virtually all of the components which appeared in one example appeared in each of the others. However, it is apparent from the plots of SDB displayed in Figure 2a and 2b that signal directed behavior occurred in both stimulus conditions, rather than in one or the other. Only Gladys showed an apparent stimulus-task interaction, having exhibited signal directed behavior in Phase 2 but not Phase 1. This task-cue condition is the same as that employed by Jenkins et al. (1978), and suggests, albeit very weakly, that the type of interaction proposed may occur. It will be possible, after the final results of the corollary condition are examined in the next experiment, to more completely analyze the results of this experiment.

The first experiment examined signal directed behavior in a design using a single feeder, similar in that aspect to the design used by Jenkins et al. (1978). The next experiment focused on signal directed behavior using two feeders. The addition of a second feeder permitted full replication of the research by Lawicka (1964) and Dobrzecka et al. (1966), and allowed for the full expression of a cue-task interaction should one operate. In that study, four different dogs confronted a paradigm in which the stimuli predicted the location of food delivery.

IV. Experiment 2: The food-location problem

Only the procedures specific to this experiment are described here. Four new dogs underwent training in a task in which food was always delivered, but location of delivery varied. The task was to discriminate the cue-feeder contingency.

A. Procedure

Reinforcers were delivered by the experimenter via one of two feeders located in the right (RF) and left (LF) front corners of the enclosure opposite the starting position (see Fig. 1). For each dog, five wieners were cut into eight approximately equal size pieces to produce 40 portions. These portions served as the reinforcers during training, each dog receiving equal numbers of pieces. The procedures employed in this problem resulted in a reinforcer being delivered on all trials.

Stimulus position as relevant cue

For this problem, CS quality was held constant while the position of the cue (R or L) predicted the feeder location (RF or LF) for US delivery. Two dogs received consistent pairings of cue and feeder location: R-RF and L-LF. The other two dogs received crossed pairings: R-LF and L-RF. This manipulation was enforced as a control for location consistency between cue and feeder. The compound cues described earlier were also used here. For two dogs, the CS was the HT compound. For the other two dogs, VB was used. The experimental conditions were:

Dogs 1-2) HT:R-RF L-LF

Dogs 3-4) VB:L-RF R-LF

Each of these conditions occurred twice, once for one dog in each pair.

Stimulus quality as relevant cue

This problem completed the two-by-two matrix of stimulus-task conditions. In this condition, S1 and S2 came from one source and predicted food delivery at RF and LF. For two dogs, HT predicted food at the right feeder (RF) while VB predicted food at the left feeder (LF). For the other dogs, the relationship was reversed. The experimental contingency enforced in this preparation was:

Dogs 1-2) HT:RF+, VB:LF+

Dogs 3-4) HT:LF+, VB:RF+

Special Training

As was the case in Experiment 1, individual response patterns interfered with training. Therefore, each of the dogs used in this experiment was given special training prior to beginning the experiment proper. Training consisted of the same procedures which have been described for Experiment 1. Dogs were given prompts and reinforcers for approaching and contacting the mat in the Start Area. The training followed habituation sessions for all four dogs in Experiment 2. Each dog responded very differently to this training, but at the general level it was successful. Three sessions of 40 trials each were scheduled. On Day 1, Kelbi received only 33 trials, however, because she began lying at the left front of the enclosure following each reinforcer. Except for this limitation on Session 1, 40 trials of instrumental training were run for each dog. Shaping was then terminated with all dogs consistently sitting on, or at least maintaining contact with, the mat.

Additional training was required for Kelbi and Dingo, both of whom showed a strong fear of the stimuli during the last habituation session. Forty trials of strict Pavlovian training were given to Kelbi and Dingo, with no success. Because this experience eliminated mat behavior, one session each of instrumental training was given, after which a different approach to the problem of CS sensitivity was tried. The amplitude of the auditory elements of the stimuli was first reduced and then gradually returned to the level used during regular training. Dropping the amplitude of the stimuli eliminated the fear response and stepping it back up over two (Kelbi) or four (Dingo) days of regular training permitted return to the previous levels. (On Day 4, ten trials of mat training were given to Dingo prior to 30 trials of regular training since she had again moved off the mat and away from the S+.) No special training other than shaping to the mat was required for Woosha and Flo, and no special training was necessary for Kelbi and Dingo after the stimuli were returned to the standard levels.

B. Results and Discussion

Habituation

Habituation in Experiment 2 was similar to that in Experiment 1 until the nonreinforced presentations of the stimuli occurred. Two dogs, Kelbi and Dingo, exhibited strong fear responses to the stimulus presentations, which were reduced only with very deliberate manipulation, as described above. Responding to stimulus onset was similar in both dogs, and included jumping, moving quickly away from the source of the stimulus, orienting to the source of the stimulus, and barking or whining at the source. This response was exhibited to all four presentations of the stimuli, and continued to be expressed during the early trials of the first session. The other two dogs showed no fear of the stimuli; one dog consistently approached the sources when the stimuli came on. This approach pattern dropped out by session 4 (see Figure 3a below). Woosha, on the other hand, did little more than orient to the sources when the stimuli were presented.

Because subjects served in both stimulus conditions of a given problem, the stimulus condition and phase are reversed for some subjects. Results have been discussed by stimulus condition; therefore, in some cases second-phase results are described before the first-phase results for an animal.

Stimulus-quality condition

Kelbi (Phase 1): During the first day of training, the fear response to the stimuli which was evident during habituation training continued. The first attempt to reduce the fear, strict Pavlovian training, was unsuccessful. The second attempt, reducing the amplitude of the auditory component of the cues, eliminated the fear reaction. Subsequently, returning the cue to its previous level resulted in no further fear reaction. Re-introduction was carried out over the next two days of training (Days 2 and 3), during which all other procedures were normal. On Day 2, when the cues were at their quietest, approach to the front of the enclosure occurred on US delivery, with some orientation to the source from the front of the enclosure. On the third day, approach to the US again occurred with occasional orienting to the source, and on a few occasions barking. By Day 4, the cues were at standard training levels, and orienting to the source was occurring from various locations about the enclosure. Beginning on Day 5, with one occurrence, signal directed behavior began to emerge. With increasing frequency, orienting to and approaching the source at onset began to appear. A response pattern similar to that described for Cleo in Experiment 1 began to appear on Day 7 with tail wagging on approach, and barking in a more playful manner than was earlier observed. The full response pattern developed on Day 9, and continued to be expressed thoughout Day 10. The complete response was very lively, and contained an approach component, barking, leap/pounce elements, and tail and/or head wagging which frequently combined to become a prancing movement of the whole body.

Dingo (Phase 1): Continued strong fear of the stimulus occurred, Pavlovian training did not eliminate it. Reducing the amplitude of the stimuli was successful, but required two additional days of re-introduction of standard training levels. Despite apparent suppression of the fear response, no signal approach was ever observed toward either source. From the first exhibition of discriminated responding, the strongest response was a direct approach to a feeder slot positioned on the same side of the enclosure as the source of the stimulus. Otherwise, Dingo approached the front of the enclosure opposite the side of the stimulus, where she remained until delivery of the US. During training in both phases, copious salivation developed, and appeared especially during early trials on all days. In addition, approach to the wrong feeder occurred only rarely. So while the stimuli never produced signal directed responding of the type documented by Jenkins et al., discriminated responding to the stimulus-feeder and the stimulus-US contingencies was strong and reliable.

Woosha (Phase 2): As in the first phase (described below), signal directed behavior occurred inconsistently in this condition. During the early part of training, approach to the front of the enclosure contained some arcing in the response. On two occasions in the first two days, nose touches were recorded at the midpoint of the approach response. Frequently during the last several days of training, approach to the right feeder at stimulus onset on both RF+ and LF+ trials was followed subsequently by approach to the left feeder just prior to or upon presentation of the US on LF+ trials.

Flo (Phase 2): Strong SDB occurred throughout this condition as it did during the last half of Phase 1 training. During Day 1 training, orienting to the source occurred during the last few seconds of the ITI, and approach appeared immediately upon stimulus onset. Approach continued past the source on a circle which terminated either at the front edge of the back half of the enclosure, or completely back to the mat. The nose "brush" response described below occurred during early training, but it, along with other components of the signal directed pattern, was not observed toward the end of the phase. Beginning on Day 4, occasional approach to the right feeder directly from the mat was observed. There followed a similar drop in other components of signal directed responding, with a corresponding increase in goal approach. By Day 7, the nose brush was rarely occurring, and responding was composed of a mix of signal and goal approaches. After trial 8 of Day 10, no further source approach occurred on trials reinforced at the right feeder.

As shown in Figure 3a, little intra- or inter-subject consistency in SDB appeared in the stimulus-quality condition of the food-location problem, excepting the complete absence of SDB in Dingo. Responding by Kelbi (Phase 1) showed an overall increase in the percentage of trials with SDB, from 0% in Session 1 to 75% in Session 10, as did that for Woosha (Phase 2, 2% to 87%). For Flo (Phase 2) the incidence of SDB dropped from a high of 100% in Session 4 to a low of 50% in Session 10.

Stimulus-location condition

Woosha (Phase 1): Only rarely did signal directed behavior appear during training, but on the few occasions in which it did, the responses were quite strong. Beginning on Day 1, there was orienting to the source from the front of the enclosure, and subsequent orienting to the source as part of the approach response. By the end of training (Days 8-10), only infrequent approach to the source occurred at stimulus onset. Approach to the source was recorded four times on Day 8, and only three trials on Day 10 had signal directed components of any kind. The prototypical response began with an orientation to the stimulus followed after 1 to 9 seconds by an orientation to the experimenter and then the feeder, and finally direct approach to the feeder.

Flo (Phase 1): Beginning in Session 6 of habituation training, Flo approached the source at stimulus onset. Initially, approaches appeared to be elicited more by curiosity than by any signal directing function that the stimulus might have had. Intuitive support for this interpretation comes from a visual analysis of the behavior pattern displayed in Figure 3b below which shows a drop in "signal directed behavior" to zero over the first four days of training. Beginning on Day 6, the frequency of signal directed behavior increased rapidly, and maintained a high level throughout the remainder of Phase 1 training and the first half of Phase 2 training. A number of characteristic response elements began to appear on Day 7, including responses labelled "nose brush" and "circle". The first of these involved apparent nose contact with the source during approach. Since the response did not interfere with approach in any noticable way, touching seemed inappropriate since it implied a somewhat longer duration of contact than did brushing. At various times both before and during presentation of S+, approach to the source of the S+ began a response which became a circle of the box, terminating on the mat in the start area. This tendency to circle the box was also represented in an oscillation response, recorded when a movement back and forth between the two front areas of the enclosure crossed the center line. Oscillation began to occur on Day 8, at a time when approach to the source was a charging approach of reasonable intensity. Approach generally continued past the source to the opposite front half of the enclosure, and then terminated at the other side. This oscillation occurred several times in succession on some trials, and usually only occurred when the S+

predicted food at the left feeder. Such responses were classified as signal directed.

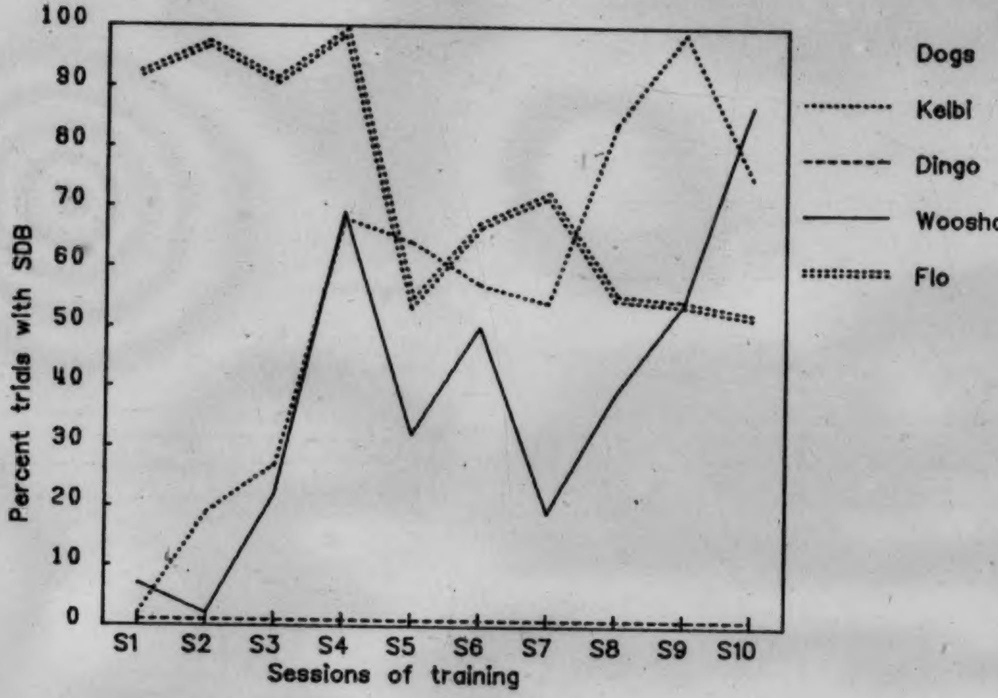
Kelbi (Phase2): SDB occurred during the first day of training. The behavior included the leap/pounce, barking, and head- and tail-wagging which were displayed in Phase 1. Frequently, approach to the source was quite rapid, appearing as a charge of the stimulus as it came on. As was the case with other dogs, this behavior attenuated over the course of training. By the eighth day, source approaches were almost totally restricted to the right side, with feeder approaches predominating behavior to the left side. However, barking and head- and tail-wagging continued throughout the ten days of Phase 2 training.

Dingo (Phase 2): Training in this phase introduced a new stimulus source (R), and with it the fear response again occurred. However, the response was not strong, and habituated without intervention. Since two sources predicted food delivery at two locations, both were avoided. Approach to the side of the enclosure opposite the source of the stimulus occurred on these trials. Behavior during the interval between stimulus onset and US delivery consisted of orienting to the source from the back of the enclosure or from a position in the opposite front of the enclosure which was taken at S+ onset. Profuse salivation to the S+ continued during early trials in a day, despite an apparent aversion to the sources. The common response consisted of approaching the opposite front of the enclosure at S+ onset, sitting facing the stimulus source and orienting to it for several seconds, and then turning to the slot at or just prior to US delivery.

Figure 3b displays the percentage of SDB trials in the stimulus-location condition of the food-availability problem. The replacement of orienting to the stimuli by SDB for Flo can be readily seen in the reversal of responding from Session 1 (47%) through sessions 4 and 5 (0%) to Session 10 (100%). The other high frequency occurrence of SDB, by Kelbi, decreased from 100% (Session 2) to 47% (Session 9). This behavior followed Phase 1 behavior which terminated at 75% SDB trials.

Figure 3a. Percent of trials per session in which SDB occurred for the stimulus-quality condition of the food-location problem.

Figure 3b. Percent of trials per session in which SDB occurred for the stimulus-location condition of the food-location problem.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Percent trials with SDB
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S2
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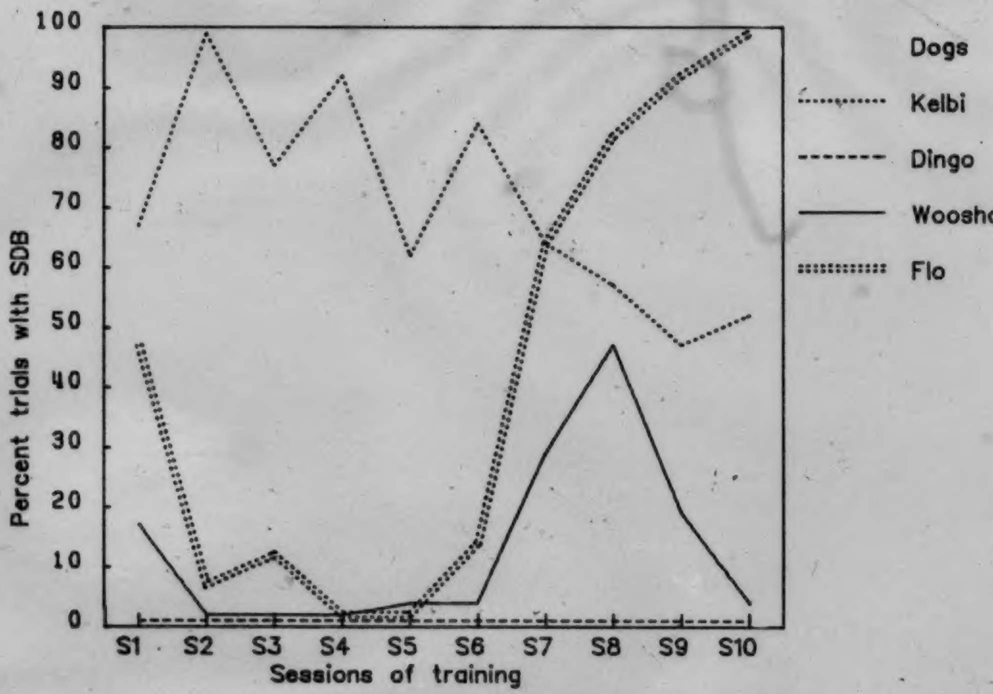
S9
S10
Sessions of training
Dogs
Kelbi
Dingo
Woosha
Flo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Percent trials with SDB
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S7
S8
S9
S10
Sessions of training
Dogs
Kelbi
Dingo
Woosha
Flo

Summary

The same global response pattern appeared in this experiment as was described in Experiment 1. Similar problems were also encountered in implementing training, as individual response patterns frequently precluded the enforcement of the criteria established for beginning a trial. While no interaction of signal and task was observed, common components of a general SDB response were observed to occur in the response patterns of three of the dogs. While these components did not occur on every trial, they did appear with regularity in the responding of Kelbi, and regularly but at a lower frequency in the behaviors of two others.

For one dog, the SDB at the end of Phase 1 and throughout Phase 2 was lively and quite animated, an exact opposite of the intial fear response displayed during habituation and early Phase 1 sessions. For two other dogs, an intermediate level of responding was obtained. In each case, the SDB was limited and somewhat attenuated. These dogs exhibited occasional signal-directed responses which were not attenuated, but by and large they were not differentially distributed across cue-task conditions. Finally, for one dog exposure to the stimuli in habituation produced a strong fear reaction which was never reversed, in that approach to the S+ never occurred. However, in all presentations of the S+ in this experiment, this dog approached the appropriate feeder during CS exposure by taking an arcing path away from the source. Given the original definition of SDB by Hearst and Jenkins (1974), this behavior might correctly be construed as sign tracking. However, this behavior was unaffected by the cue-task condition imposed.

V. General Discussion

In neither Experiment 1 nor Experiment 2 were interactions between stimulus condition and task apparent. To conclude that an interaction had taken place would require the differential occurrence of signal directed behavior in one condition relative to the other, which did not occur. Plots of the incidence of SDB show that it was not a function of the task requirements, which it would have been had an interaction occurred, since the presence of SDB and/or its relative frequency are comparable across tasks involving both stimulus-quality and stimulus-location problems. Further, the seeming total absence of signal approach in Dingo and its minimal expression by Woosha refute even a weak conclusion of a cue-task interaction.

Not even post hoc explanations can be offered to elucidate the dogs' behavior. Although a variety of factors might be proposed to explain the results of these studies, no real clarification is obtained. For example, it may be suggested that a trials effect operated to preclude signal directed behavior by Kelbi and Flo across the two phases. However, the reversed phase order for these dogs negated any specific conditions effect. Further, Woosha's behavior pattern approximated that of Kelbi across Phases 1 and 2, but her phase order was the same as Flo's, so order of testing does not appear to be critical.

One further problem was the expression of the avoidance response by Dingo and Gretchen. They consistently failed to display SDB in the manner expected, but instead tended to avoid the CS by following an arcing path away from the stimulus. That they continued to do so during the course of the study would suggest that although they failed to demonstrate SDB, they did acquire an association between the cue and the food, as indicated by their approach to the correct feeder prior to US delivery. It may be that fear elicited by the stimuli precluded the demonstration of SDB in these two dogs. A more liberal interpretation of the phenomenon as defined by Hearst and Jenkins (1974) would conclude simply that the form of sign tracking developed in these dogs did not include signal approach.

Thus, the cue-response interaction of the type described by Lawicka (1964) was not demonstrated. Whether there might be a task-cue interaction in this extended design remains to be demonstrated definitively. Of course, failure to find the interaction cannot be construed as evidence that the interaction did not occur, and so the hypothesis of an interaction in SDB cannot be rejected yet. The three broad possibilities for the present failure to find an interaction can be quite simply stated. Two assume that no interaction occurred for the behavior which was displayed. In one, conditions of the design precluded their expression. In the other, no interaction should have been expected. The third possibility is that an interaction occurred but simply was not detected.

The first possibility to be examined is that the interaction that was demonstrated in Konorski's lab may have been restricted in some way to the preparation which they employed. Since no systematic examination of the differences between the present design and those employed in Konorski's lab was pursued, one can only speculate about potential differences. One possibility is that the stimulus-task competition which existed in the cue-specificity experiments which were conducted in Konorski's lab, where different attributes of the cue were related to reinforcement, did not exist in the present preparation. The Konorski preparation required that dogs learn to respond differentially to cues having both location and quality attributes. The cues were then modified so that each location cue was recombined with the alternate quality cue. Then, in a test of stimulus control using the new cues, note was made whether the location or the quality element of the new cue was the better predictor of the emitted response. In this way it was possible to separate the relative degree of control by each component of the compound cue.

For the dogs in the present study, however, presentation of any cue was perfectly correlated with delivery of the reinforcer in all sessions. At no time was either component of either cue separated from the other component, as was the case for the Konorski design; S+ and S- kept their integrity in a given preparation. That is, a discrimination condition existed, but the target cue was always the target cue. Once that was learned, no competition existed. So separating SDB into some parts governed by cue quality and other parts governed by cue location should not be anticipated. That it failed to appear may reflect a substantive flaw in the two designs of importance to this dicussion.

A second possibility for the failure to obtain an interaction in this study may be that the experimental procedures blocked or simply did not facilitate its appearance. In the research which precipitated the interaction hypotheses, only stimulus location training was given to each dog, whereas in this study each dog was trained on both signal quality and signal location training. Chaining the two procedures may have attenuated any individual effect each may have.

That this may have occurred is suggested by an extension of the criticism Rescorla and Holland (1976) directed at some studies of interactions. They argued that assumptions of selective association must be held in abeyance until questions about differential performance (arising from differential experimental training, for example) are answered. It might be suggested even further that some apparent interactions may exist only when differential training is experienced, and that employing the full cross-over design which they specified seriously attenuates possible interaction outcomes.

The first two possible reasons for the failure to find an interaction in this research suggested that some form of interaction exists, but that designs which have successfully produced it are in some way restricted or limited in their applicability. The final possibility is that an interaction existed but that it simply was not detected. Several factors may have combined to produce this result.

An examination of the plots of the percent of trials per session in which SDB was shown (refer to Figures 1 through 4) discloses that the trial-by-trial levels of SDB changed between sessions and phases both within subjects and between subjects. With the variability of incidence per session came also a variability in the nature of SDB on any one trial, so that detecting a constant or nearly constant pattern that was specific to one training condition was rendered quite difficult. Compounded with the problem of variability in SDB was the occurrence of a strong fear response in Dingo and Gretchen, and the behavior of Minnie. So it is possible that with more stable behavior, the interaction may have been seen, perhaps as a difference in trials to first appearance, incidence per session, magnitude of expression, or some other measure or combination of measures of the basic SDB response.

Analyzing only whether or not a dog ever displayed SDB in a given condition permits constructing Table 4, which shows the proportion of dogs in each condition exhibiting SDB. Because of the nature of the data (it is correlated and

Table 4

Proportion of Dogs Exhibiting Signal Directed Behavior Before (upper table) and After (lower table) Excluding Dogs Never Showing Signal Directed Behavior

Proportions of all eight dogs showing signal directed behavior as a function of stimulus and problem type

	Go/No-Go	R-L Diff
Stimulus Quality	0.25	0.75
Stimulus Location	0.50	0.50

Proportions of the five dogs showing signal directed behavior as a function of stimulus and problem type

	Go/No-Go	R-L Diff
Stimulus Quality	0.50	1.00
Stimulus Location	1.00	0.67

n≤5), no direct analysis is possible. However, the problem of correlation can be resolved by collapsing the data into four independent groups within each task, and identifying whether a dog displayed SDB in one or both cue conditions. Those four groups and the relative incidence of occurrence of SDB within task and cue condition are:

SDB in both conditions	1	3
SDB in location condition	1	0
SDB in quality condition	0	0
SDB in neither condition	2	1

The distribution of animals would have had to be restricted to the middle four cells to compel further analysis of the data. Therefore, no further analysis of this data is demanded. Although the possibility of an interaction is suggested by the top array in Table 4, the four-group data does not support that suggestion. It may be, however, that some additional information can be gathered from a closer analysis of the individual behavior of the dogs.

Consider first that three of the dogs (Dingo, Gretchen, and Minnie) failed to display SDB thoughout the study. Excluding those dogs may be justified on the grounds that subjects not showing the behavior at all cannot respond differently between conditions. Recognizing the problems of discarding subjects and placing too much trust in engineered analyses, the lower portion of Table 4 was constructed to represent the behavior of the five dogs whose behavior was signal directed. It again appeared, however, that an interaction may be producible under more rigorous experimental conditions. In the cases of both the original and new proportions, there are patterns in the single cue condition. As before, however, no simple analysis is possible. Given the frequencies from the four independent groupings, no further analysis was warranted.

Clarification of the results of the present research will require a much more stringent examination of SDB in the Konorski paradigm than was carried out here. Several refinements of the design and apparatus used in the present research might permit a finer analysis of behavior under stricter experimental conditions. One possibility would be to employ one pure-strain species of dog, raised under sufficiently stable conditions to reduce inter-subject variability. At least two problems might arise from this approach. First, it might be questioned whether a successful reduction of the kinds of "problem" variation described here would restrict the scope of the subsequent study to parametric examination of the SDB preparation. That was one of the basic criticisms leveled at the earlier work of Holland, wherein his focus on the preparation drew attention from what were argued to be more important aspects of the research. In other words, removing the natural variation and spontaneity of behavior may sufficiently redirect this study as to change its basic focus. In the long run, too, such a goal may be met only with difficulty, if at all. As Jenkins et al. (1978) implied in their discussion, the kinds of behavior which a dog can bring to such a test are varied and dynamic. Lorenz (1952) pointed out important differences in the social responsiveness of dogs of two general lines, Canis lupus and C. aureus, and discussed the relative ease with which each can be domesticated or trained to respond to humans. Further, several researchers (Fox, 1971; Scott & Fuller, 1965; and Scott, 1967) have found that as dogs develop, behavior patterns critical to expression of SDB, such as play, sex, aggression, and feeding, frequently become more variable and exaggerated, often incorporating components of other systems, and are quite sensitive to gene-environment interaction at the individual level. Each of these changes militates strongly against reducing variability sufficiently to detect subtle between-condition differences.

Despite individual differences in responding, general SDB responding approximated that described by Jenkins et al. The generic response of the five dogs which showed SDB consisted of orienting to and approaching the S+ almost immediately upon its onset. On some trials the response contained a pause at the location of the stimulus while on others the subject continued to the feeder slot. Further, on some trials the dogs returned to the stimulus (or looked back at it) prior to its termination and food delivery. However, these elements of responding did not appear for all occurrences of SDB nor did a subset of them occur consistently for any one dog. While none of the specific patterns described by Jenkins et al. appeared, all of the components of those patterns were observed at one time or another in the behavior of the five dogs showing SDB. For example, Jenkins et al. recorded orientation back to the source of the S+ and an insertion of the dog's nose into the food delivery slot for their Dog 2. In the present study, orienting to the source of the S+ was observed in several animals, and the nose poke reponse was observed in another. Finally, the active behavior described for Dog 4 was also observed here with virtually all of the molar components, such as barking, lunging, and crouching, occurring frequently and reliablly.

It would be comforting to conclude that SDB was a function of the cue and task conditions, as the initial discussion proposed. The demonstration of an interaction would suggest that even with evolutionary origins, important species behavior follows some more specific rules of performance. It would be less comforting, but still satisfying, to have found comparable performance in both conditions for all eight dogs. In this instance, advocacy of an ethological model would made easier. Unfortunately, the results were neither supporting nor rejecting of an interaction hypothesis, since some trends appeared, albeit weak ones. In the absence of evidence to decide, judgement must of course be suspended. In the end it must be the fate of any study which fails to find in favor of one or another view that both must stand.

Bibliography

Boakes, R. A. Performance on learning to associate a stimulus with positive reinforcement. In H. Davis & H. M. Hurwitz (Eds.), *Operant-Pavlovian interactions*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1977.

Brown, J. L. *The evolution of behavior*. New York: W. W. Norton, 1975.

Brown, P. L., and Jenkins, H. M. Auto-shaping of the pigeon's key-peck. *Journal of the Experimental Analysis of Behavior*, 1968, *11*, 1-8.

Buzsaki, G. The "Where is it?" reflex: Autoshaping the orienting response. *Journal of the Experimental Analysis of Behavior*, 1982, *37*, 461-484.

Davey, G. C. L., Cleland, G. G., and Oakley, D. A. Applying Konorski's model of classical conditioning to signal-centered behavior in the rat: Some functional similarities between hunger CRs and sign-tracking. *Animal Learning and Behavior*, 1982, *10*, 257-262.

Dobrzecka, C., Szwejkowska, G., and Konorski, J. Qualitative versus quantitative cues in two forms of differentiation. *Science*, 1966, *153*, 87-89.

Foree, D. D., and LoLordo, V. M. Attention in the pigeon: Differential effects of food-getting versus shock-avoidance procedures. *Journal of Comparative and Physiological Psychology*, 1973, *85*, 551-558.

Fox, M. W. *Integrative development of brain and behavior in* *the dog*. Chicago: University of Chicago Press, 1971.

Gormezano, I., and Kehoe, E. J. Classical conditioning: Some methodological-conceptual issues. In W. K. Estes (Ed.), *Handbook of learning and cognitive processes: Conditioning and behavior theory* (Vol. 2). Hillsdale, NJ: Erlbaum, 1975.

Gormezano, I., and Moore, J. W. Classical conditioning. In M. Marx (Ed.), *Learning: Processes*. New York: Macmillan, 1970.

Hearst, E., and Jenkins, H. M. *Sign-tracking: The stimulus-reinforcer relation and directed action.* Austin, Texas: The Psychonomic Society, 1974.

Hemmes, N. S. Behavioral contrast in pigeons depends upon the operant. *Journal of Comparative and Physiological Psychology*, 1973, *85*, 171-178.

Holland, P. C. Conditioned stimulus as a determinant of the form of the Pavlovian conditioned response. *Journal of Experimental Psychology: Animal Behavior Processes*, 1977, *3*, 77-104.

Holland, P. C. Differential effects of omission contingencies on various components of Pavlovian conditioned responding in rats. *Journal of Experimental Psychology: Animal Behavior Processes*. 1979a, 5, 178-193.

Holland, P. C. The effects of qualitative and quantitative variation in the US on individual components of Pavlovian appetitive conditioned behavior in rats.

Animal Learning and Behavior, 1979b, *7*, 424-432.

Holland, P. C. Influence of visual conditioned stimulus characteristics on the form of Pavlovian appetetive conditioned responding in rats. *Journal of Experimental Psychology: Animal Behavior Processes*, 1980a, *6*, 81-97.

Holland, P. C. CS-US interval as a determinant of the form of Pavlovian appetitive conditioned responses. *Journal of Experimental Psychology: Animal Behavior Processes*, 1980b, *6*, 155-174.

Jenkins, H. M., Barrera, F. J., Ireland, C., and Woodside, B. Signal-centered action patterns of dogs in appetitive classical conditioning. *Learning and Motivation*, 1978, *9*, 272-296.

Konorski, J. *Integrative activity of the brain*. Chicago: University of Chicago Press, 1967.

Lawicka, W. The role of stimuli modality in successive discrimination and differentiation learning. *Bulletin de l'Academie Polonaise des Science Classe II*, 1964, *12*, 35-38.

LoLordo, V. M. Selective associations. In A. Dickinson and R. A. Boakes (Eds.), *Mechanisms of learning and motivation: A memorial volume to Jerzy Konorski*. Hillsdale, NJ: Erlbaum, 1979.

LoLordo, V. M., and Furrow, D. R. Control by the auditory or the visual element of a compound discriminative stimulus: Effects of feedback. *Journal of the Experimental Analysis of Behavior*, 1976, *25*, 251-256.

LoLordo, V. M., McMillan, J. C., and Riley, A. L. The effects upon food-reinforced pecking and treadle-pressing of auditory and visual signals for response-independent food. *Learning and Motivation*, 1974, *5*, 24-41.

Lorenz, K. [Companions as factors in the bird's environment.] *Journal of Ornithology*, 1935, *83*, 137-213,289-413. (Brown, J. L. *The evolution of behavior*. New York: Norton, 1975.

Lorenz, K. *King Solomon's Ring*. New York: Signet, 1972.

Mackintosh, H. J. *The psychology of animal learning*. London: Academic Press, 1974.

Pavlov, I. P. [*Conditioned reflexes*]. (G. V. Anrep, Ed. and trans.). New York: Dover Publications, 1960. (Originally published, 1927.)

Prokasy, W. F. Classical eyelid conditioning: Experimenter operations, task demands, and response shaping. In W. F. Prokasy (Ed.), *Classical conditioning: A symposium*. New York: Appleton-Century-Crofts, 1965.

Rescorla, R. A., and Holland, P. C. Some behavioral approaches to the study of learning. In E. Bennett and M. R. Rosenzweig (Eds.), *Neural mechanisms of learning and memory*. Cambridge, MA: MIT Press, 1976.

Schwartz, B. *Psychology of learning and behavior*. New York: W. W. Norton and Co., Inc., 1978.

Scott, J. P. The future of behavior genetics. In A. R. Kaplan (Ed.), *Human behavior genetics*. Springfiels, IL:

Charles C. Thomas, 1976.

Scott, J. P., and Fuller, J. L. *Genetics and the social behavior of the dog*. Chicago: University of Chicago Press, 1965.

Shettleworth, S. J. Constraints on learning. In D. S. Lehrman, R. A. Hinde, and E. Shaw (Eds.), *Advances in the study of behavior* (Vol. 4). New York: Academic Press, 1972.

Shettleworth, S. J. Constraints on conditioning in the writings of Konorski. In A. Dickinson and R. A. Boakes (Eds.), *Mechanisms of learning and memory: A memorial volume to Jerzy Konorski*. Hillsdale, NJ: Erlbaum, 1979.

Skinner, B. F. Superstition in the pigeon. *Journal of Experimental Psychology*, 1948, *38*, 168-172.

Staddon, J. E. R., and Simmelhag, V. L. The "superstition" experiment: A reexamination of its implications for the principles of adaptive behavior. *Psychological Review*, 1971, *78*, 3-43.

Williams, D. R., and Williams, H. Auto-maintenance in the pigeon: Sustained pecking despite contingent non-reinforcement. *Journal of the Experimental Analysis of Behavior*, 1969, *12*, 511-520.

Woodruff, G., and Williams, D. R. The associative relation underlying autoshaping in the pigeon. *Journal of the Experimental Analysis of Behavior*, 1976, *26*, 1-13.

Zajonc, R. R. Feeling and thinking: Preferences need no inferences. *American Psychologist*, 1980, *35*, 151-175.

Appendix 1

The codes which follow represent all of the behavior which was recorded during training. Decisions about the presence or absence of SDB on a trial were based on an evaluation of several aspects of the overall behavior. In classifying a given trial as being an SDB trial, the following criteria were used. A response must have been clearly directed at the source: taking a straight path from the start area toward the S+. If the path changed direction during the response, the change had to be sharp. An angled change was accepted, but a curving change was not. Head-forward approach to the feeder(s) was not classified as SDB, but a side-stepping approach to the feeder accompanied by constant attention to the S+ was accepted. Further, the rejection of an arcing path response was sometimes qualified by other behaviors which occurred concurrently. Specifically, the five final responses in the list would have been sufficient to change the classification of a trial from a non-SDB to an SDB trial.

Rating Scale

Responses	Scoring Code	Special item description
Sit	sit	
Stand	st	
Orient	or	Movement of head to face object
Sniff	sn	
Lick	(no code)	
Respond	r	Initial movement toward source or front
Check	(no code)	Short glance, usually at source
Arc(+/-)	(no code)	Approach to front deflected toward S
CS+ resp	(no code)	Stereotypical response developed after extensive training and slightly different for each dog
Oscillate	osc	Movement back and forth between front areas during S+
Nose touch	nt	
Wag tail	wt	
Wag head	wh	
Prance	(no code)	Active movement of body including head and tail wagging and rapid foot movement
Jump/leap	(no code)	

Locations	Scoring code
Mat	M
Back left	BL
Back center	BC
Back right	BR
Left source	LS
Left front	FL
Right source	RS
Right front	FR
Front center	FC

Descriptors	Scoring code
Source of S+	SO+
Source of S-	SO-
Slot	SL
Plate	PL
Floor	FL
Experimenter	E
Hind legs	HL
Left	L
Right	R
Center	C
Not	(bar over code)

Appendix 2

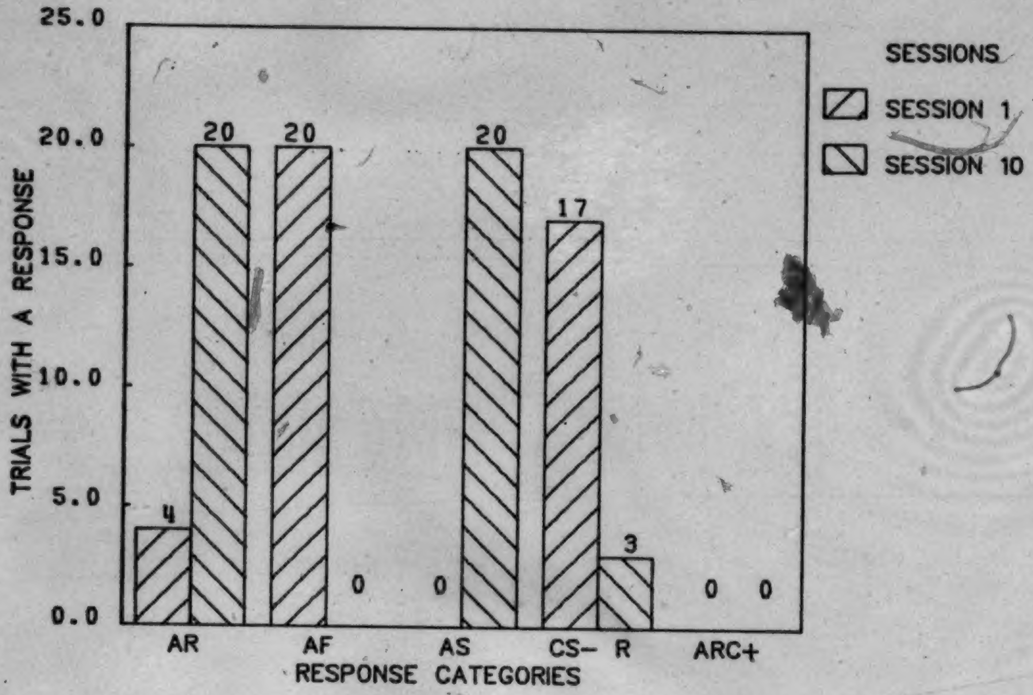
The eight following pages in this appendix display the frequency of responding in either five (Experiment 1) or four (Experiment 2) categories. These response categories comprised the data used in the primary descriptions in the two results sections. The first category of responses indicates the number of times each dog responded prior to delivery of the US. The next three categories have been described in Appendix 1. The last category displays the frequency of responses observed during presentation of the CS- in the Go/No-go training . The categories have been coded in the figures; the codes and categories are:

Category	Code
Anticipatory response	AR
Feeder approach	AF
Source approach	AS
Arc response	ARC+
Response to CS-	CS- R

Figure 4. Response frequencies in the location problem for Cleo

Figure 5. Response frequencies in the quality problem for Cleo

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR CLEO



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR CLEO

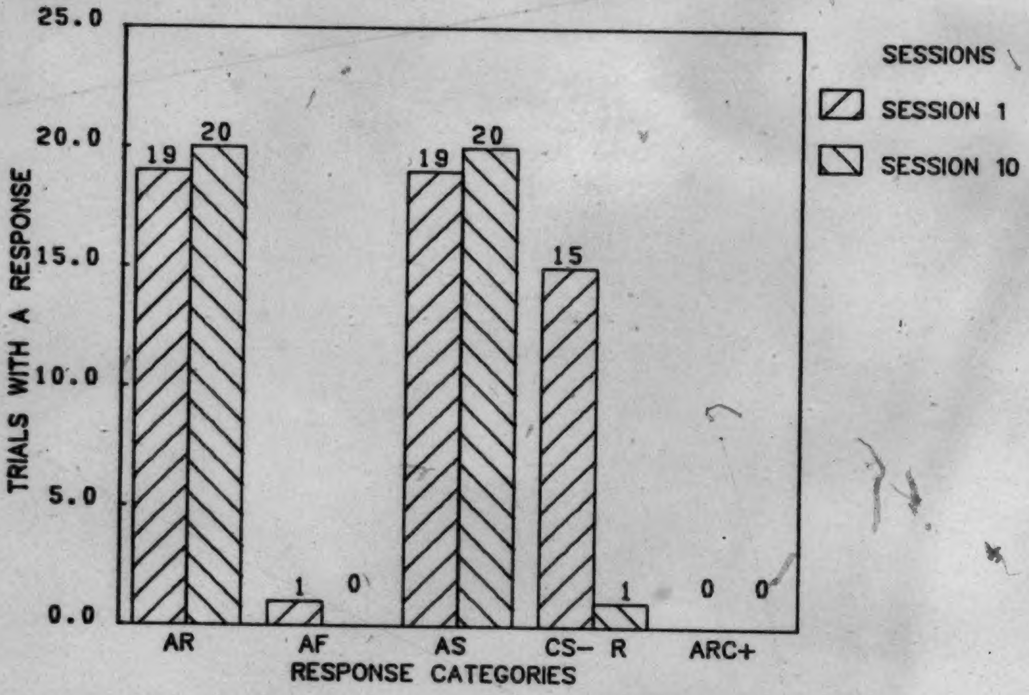
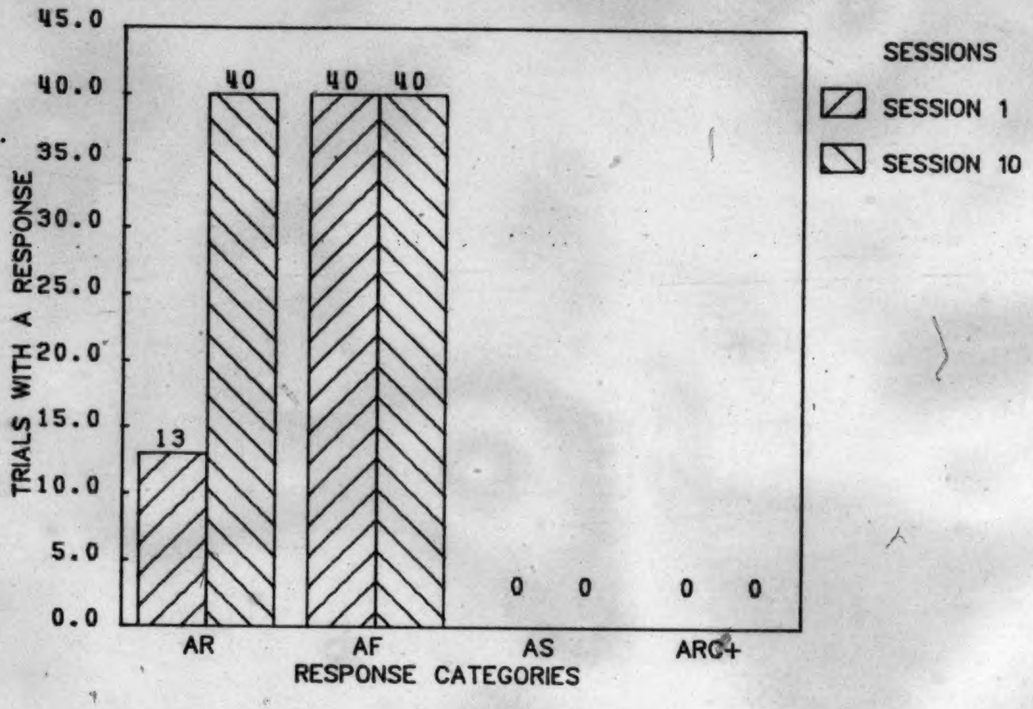


Figure 6. Response frequencies in the location problem for Dingo

Figure 7. Response frequencies in the quality problem for Dingo

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR DINGO



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR DINGO

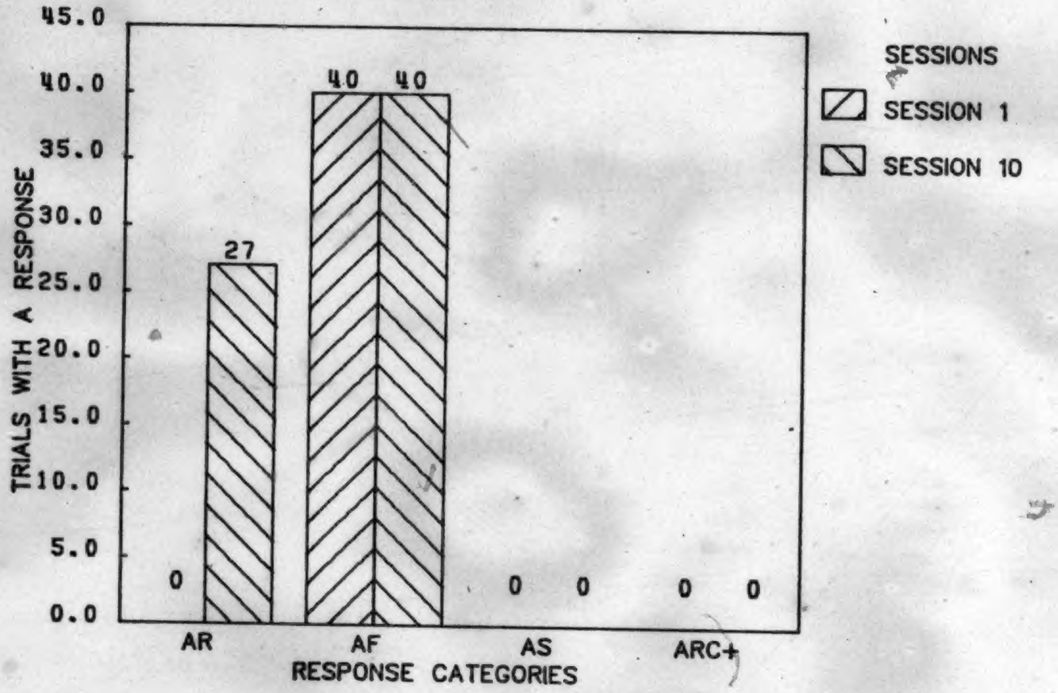
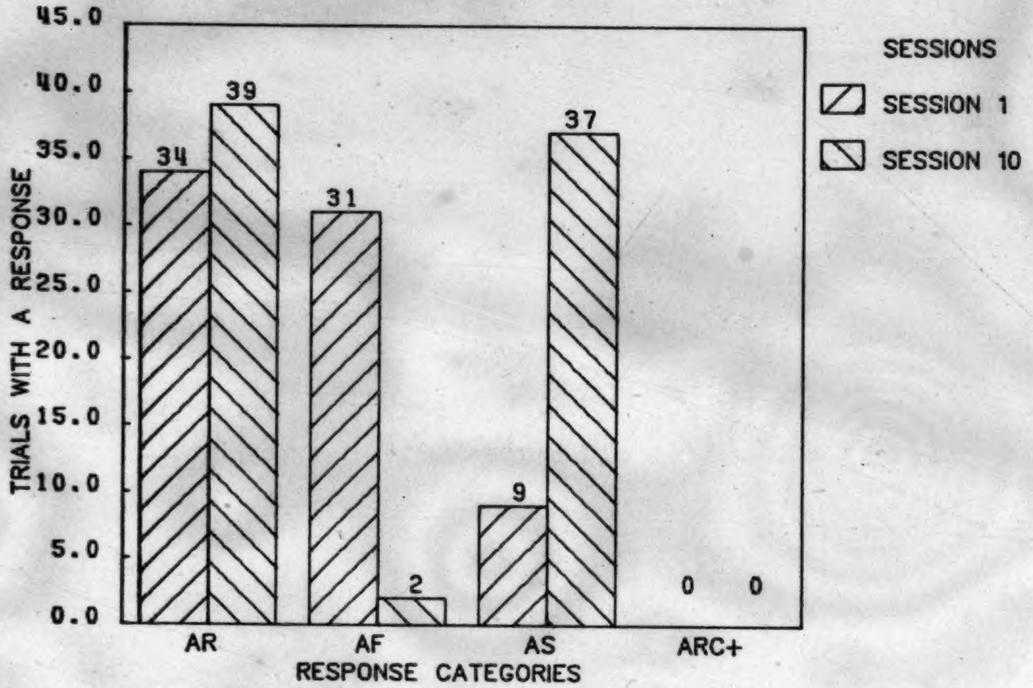


Figure 8. Response frequencies in the location problem for Flo

Figure 9. Response frequencies in the quality problem for Flo

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR FLO



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR FLO

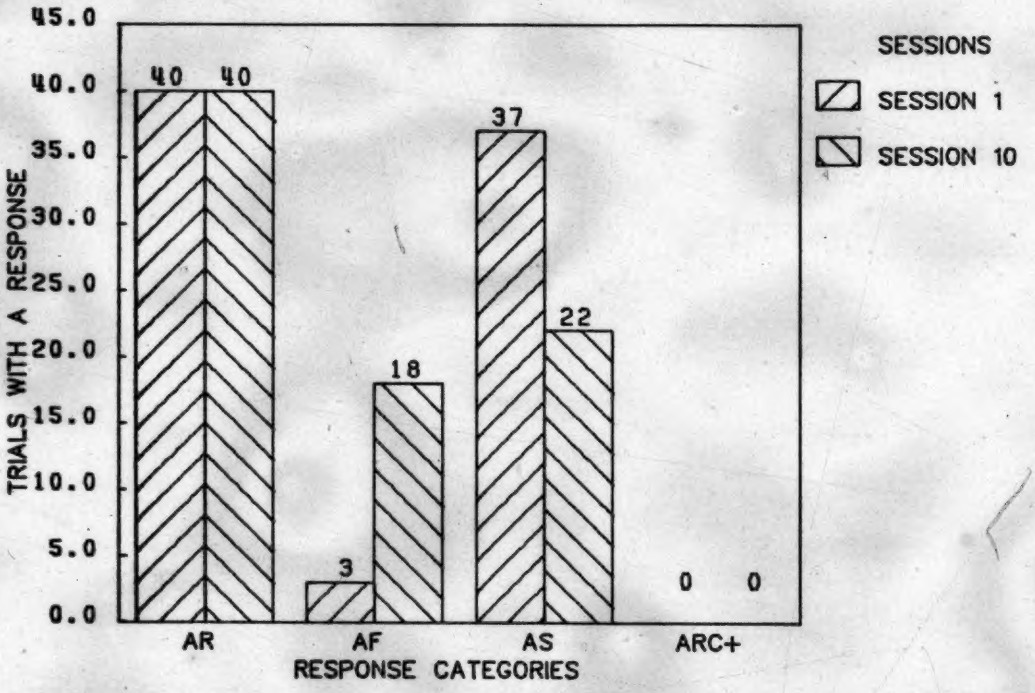
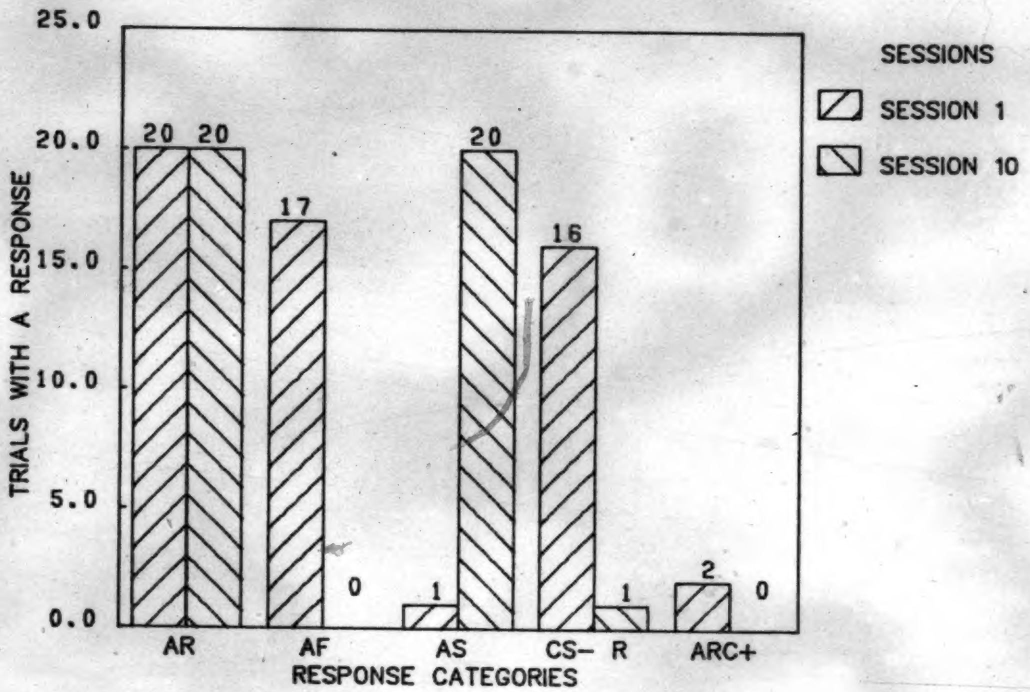


Figure 10. Response frequencies in the location problem for Gladys

Figure 11. Response frequencies in the quality problem for Gladys

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR GLADYS



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR GLADYS

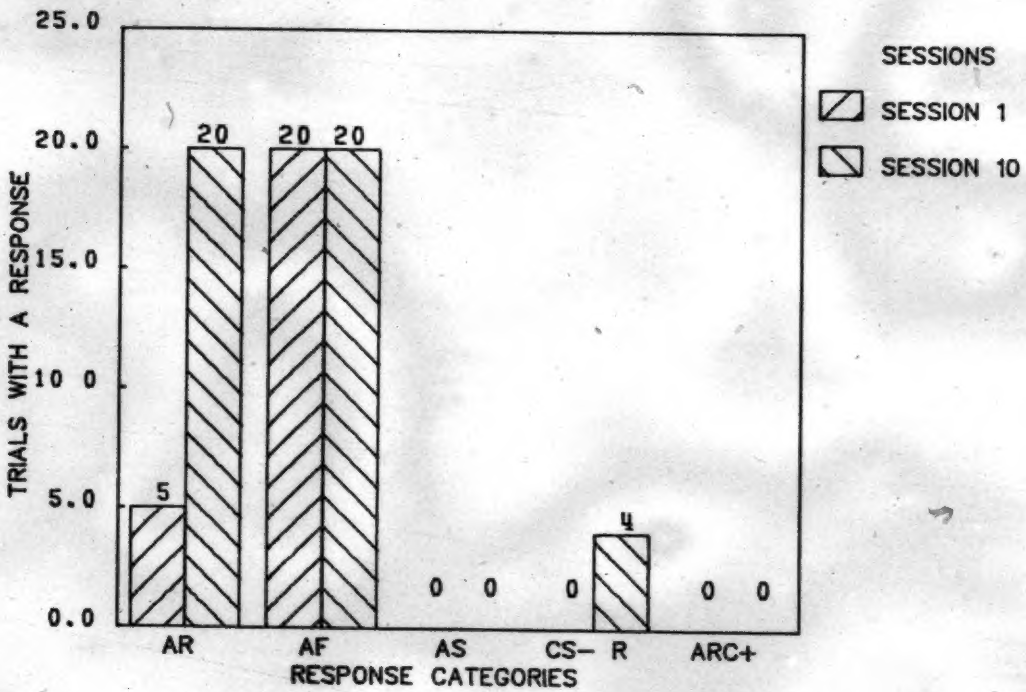
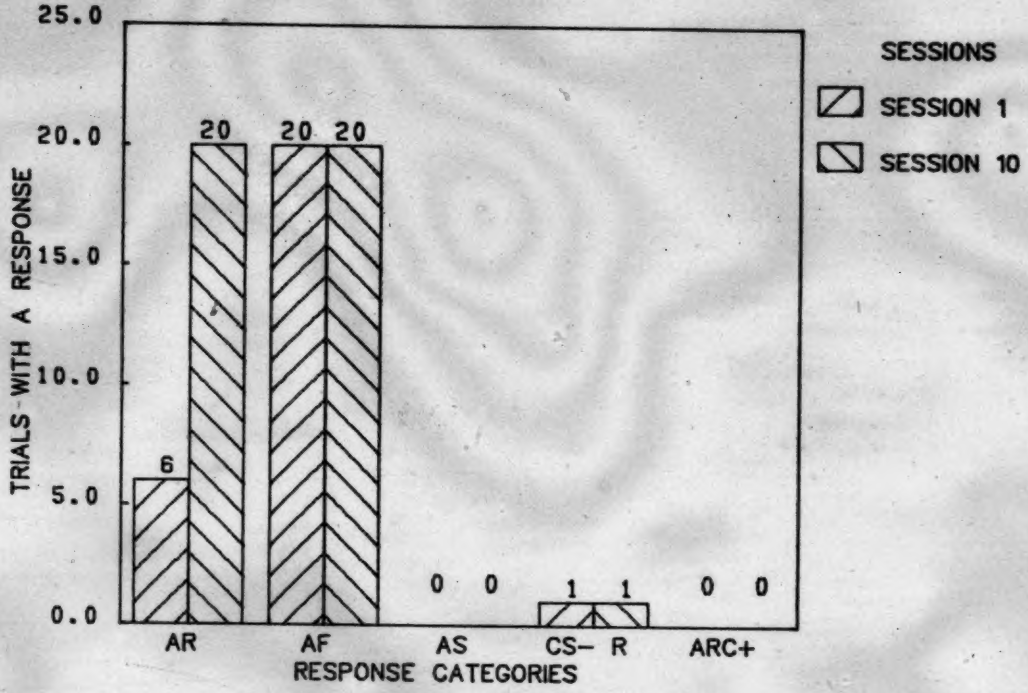
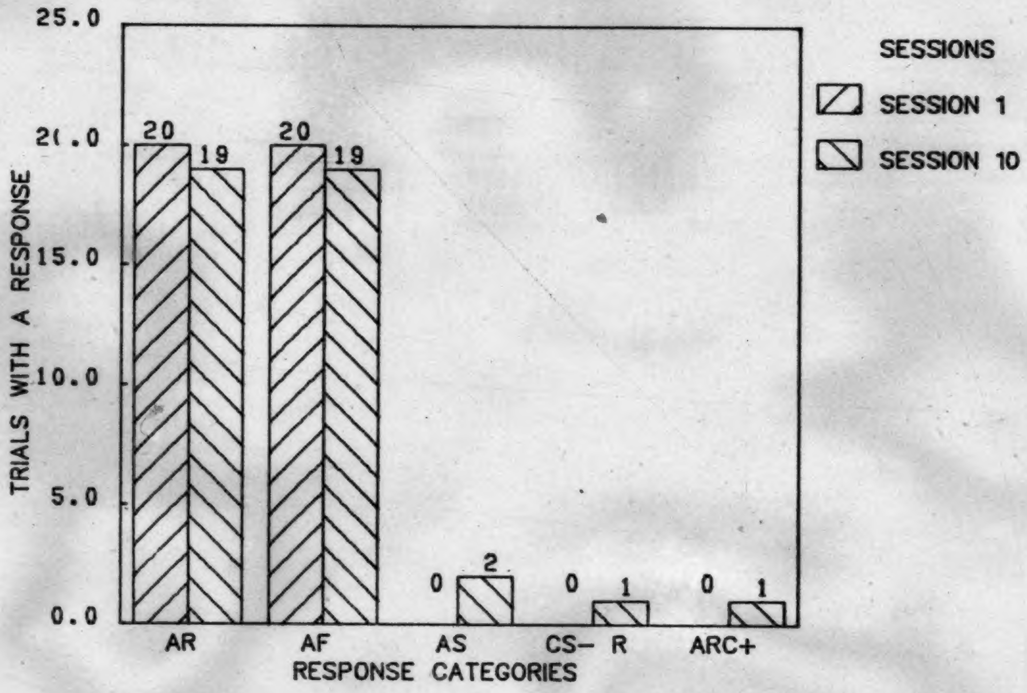


Figure 12. Response frequencies in the location problem for Gretchen

Figure 13. Response frequencies in the quality problem for Gretchen



RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR GRETCHEN

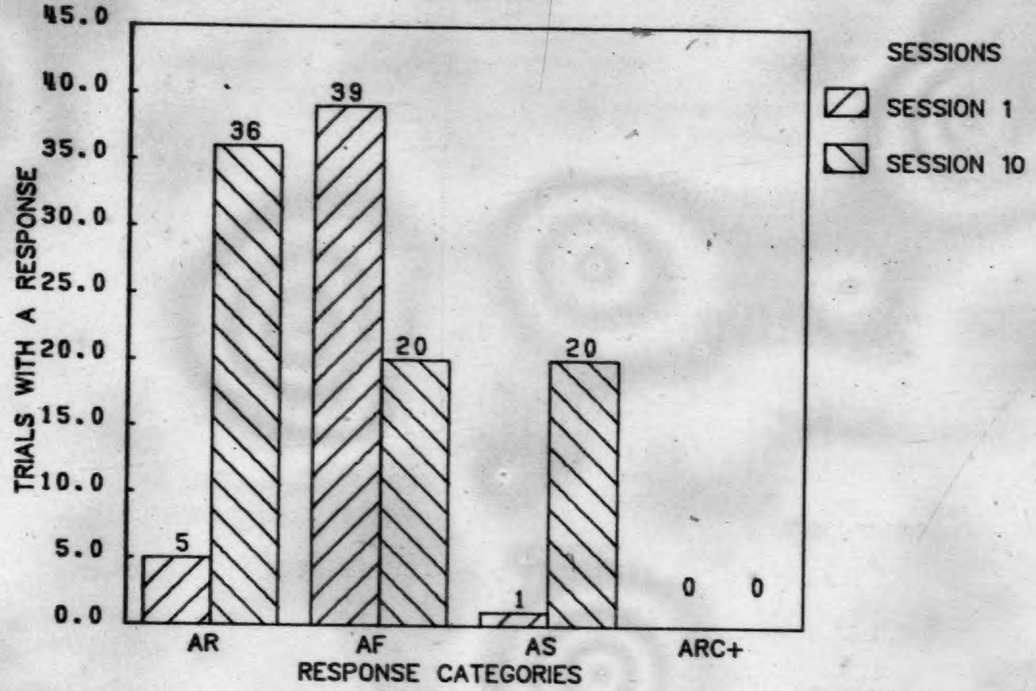


RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR GRETCHEN

Figure 14. Response frequencies in the location problem for Kelbi

Figure 15. Response frequencies in the quality problem for Kelbi

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR KELBI



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR KELBI

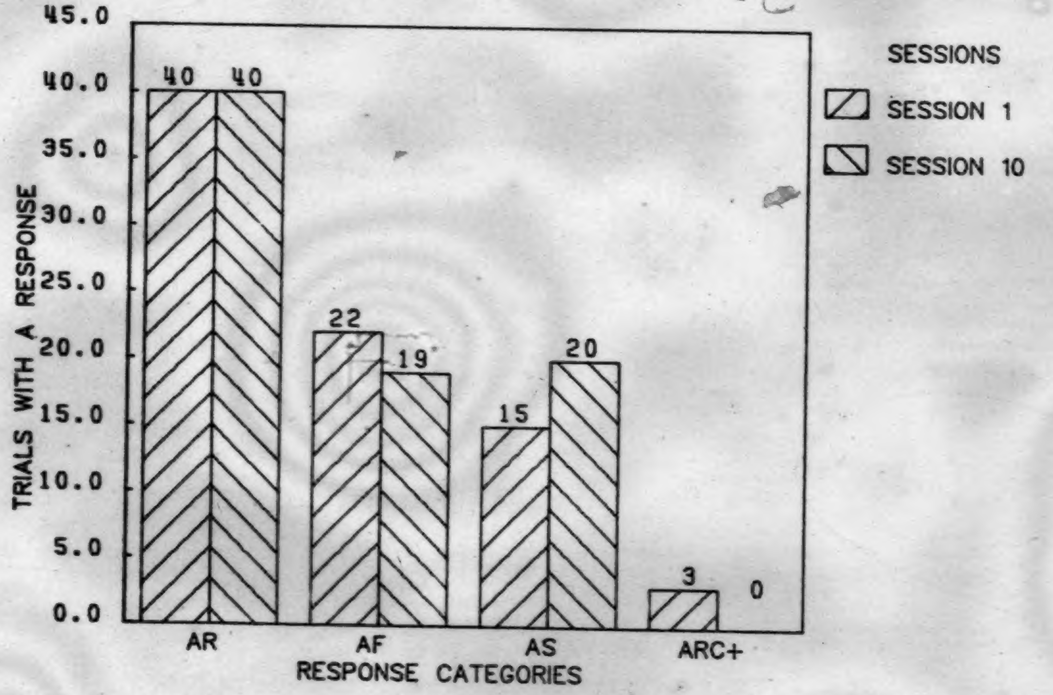
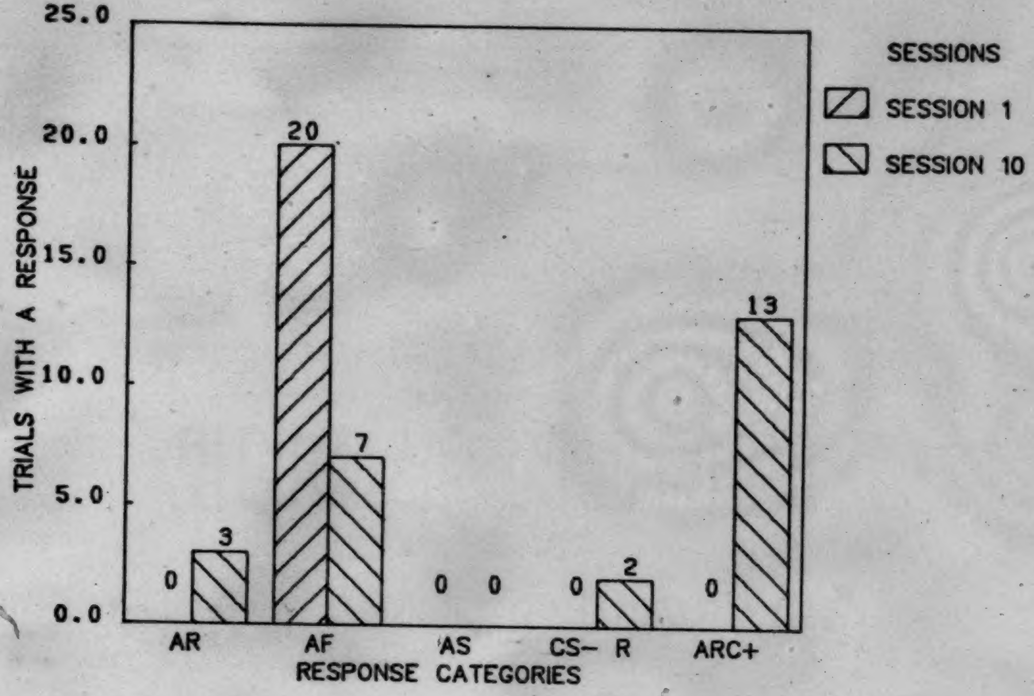


Figure 16. Response frequencies in the location problem for Minnie

Figure 17. Response frequencies in the quality problem for Minnie

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR MINNIE



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR MINNIE

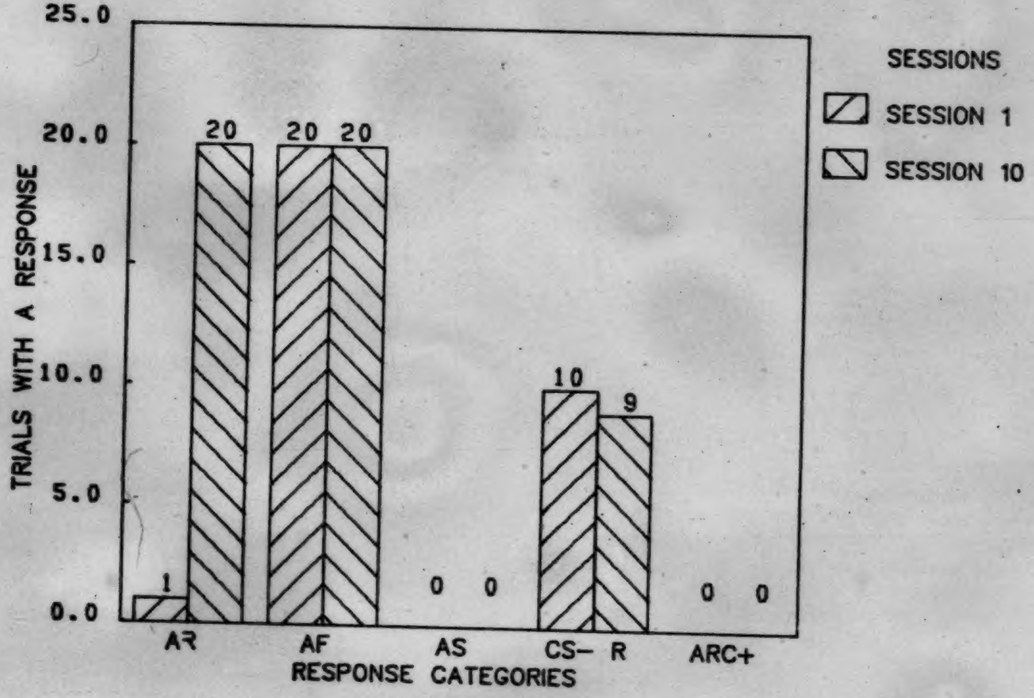
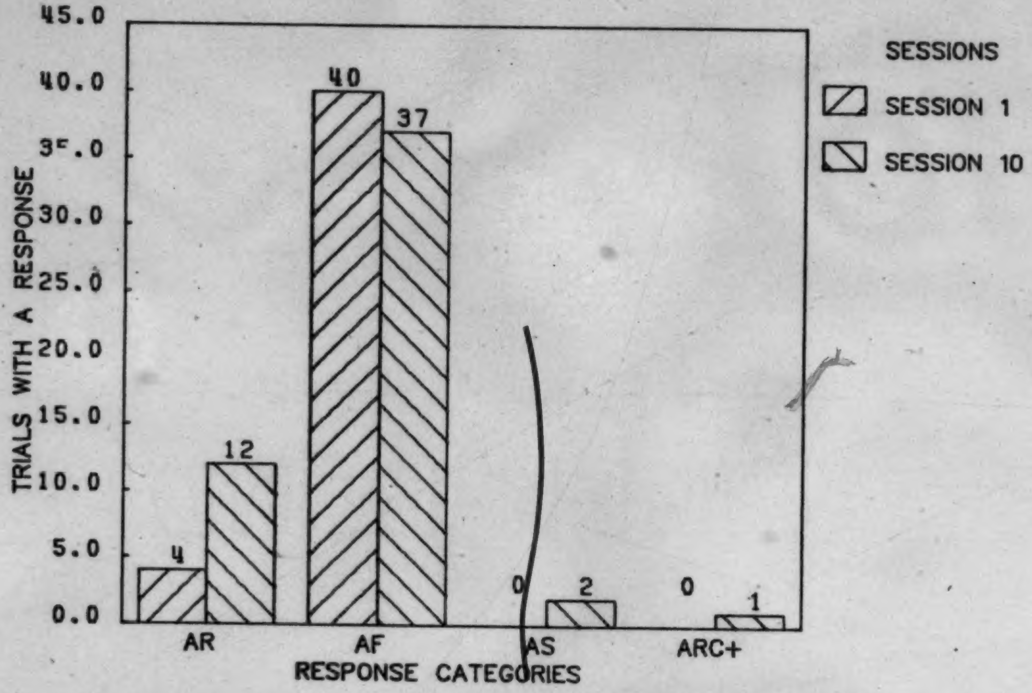


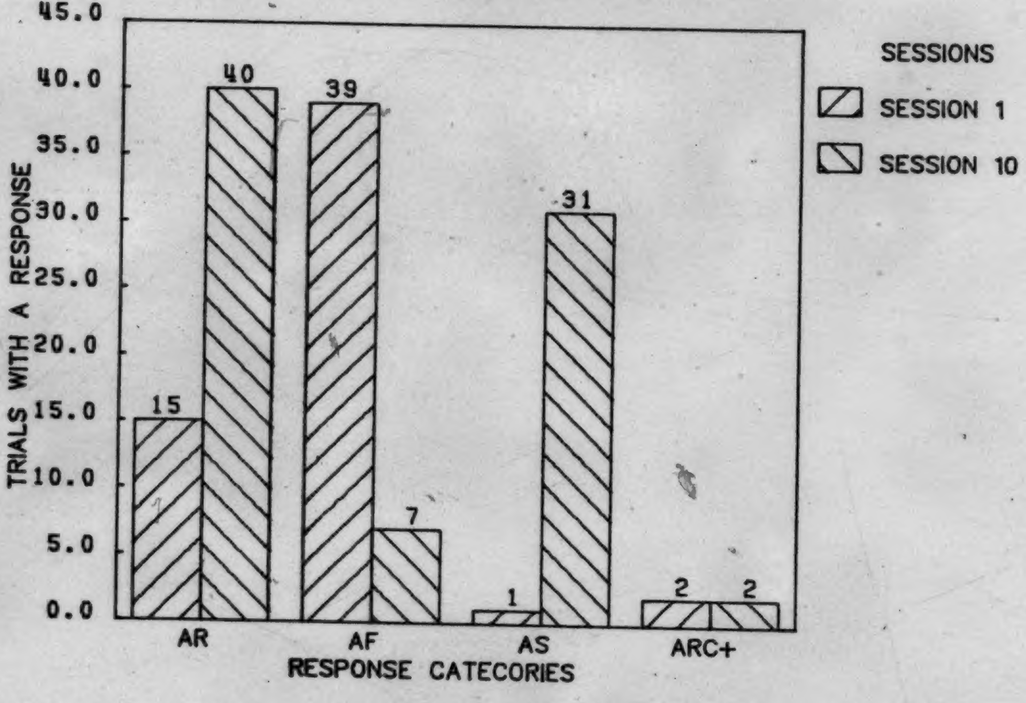
Figure 18. Response frequencies in the location problem for Woosha

Figure 19. Response frequencies in the quality problem for Woosha

RESPONSE FREQUENCIES IN THE LOCATION PROBLEM FOR WOOSHA



RESPONSE FREQUENCIES IN THE QUALITY PROBLEM FOR WOOSHA



Appendix 3

Reliability was measured using video tape of training for the four dogs in the second experiment. Trials were selected unsystematically from the video tape and transferred to a video cassette for observer training and testing. Two independent observers were shown a 30-minute segment of video tape displaying trials similar to those to be used for testing. Ninety (90) trials were presented in a single block for the testing, distributed approximately equally across the four dogs: 24, 23, 22, and 21 trials. Responding on a given trial was classified as a feeder approach, a source approach, or an arcing approach to the feeder (with displacement toward the source).

The following agreements were obtained:

Perfect agreement on 50 trials broken down as 34 feeder approaches, 11 source approaches, and five arcs.

Agreement between the experimenter and one external rater on 26 trials, as follows: 12 feeder approaches, six source approaches and eight arcs.

Agreement between the two external raters (but not the experimenter) on 12 trials: three feeder approaches (E: three arcs) and nine arcs (E: five source approaches, four feeder approaches).

Complete disagreement on two trials (E: two source approaches). Each rater was internally consistent, giving the same classification on both trials.

The percent agreement, at each level and summed within agreement and disagreement, were:

Degree of Agreement	% trials	Cum % trials
Perfect	55.6	55.6
With one external	28.9	84.4
With no external	13.3	13.3
No agreement	2.2	15.5

Several characteristics of the rating trials support the argument that these figures are conservative. On several trials where there was disagreement between the experimenter and observers, an arc occurred in the feeder approach which was away from the source of the signal. This type of arc was not differentiated from a source approach arc during rater training. Modifying this difference would raise the overall agreement with at least one of the two external raters to just over 91%.